THE BRITISH JOURNAL

OF

OPHTHALMOLOGY

SEPTEMBER, 1945

COMMUNICATIONS

THE ORIGIN AND PURPOSES OF BLINKING*†

BY

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THIS enquiry was begun some years ago in order to find out to what extent the rate of blinking is reduced in the chronic encephalitic. As there were no normal standards taken under such special conditions as the encephalitics were, alone, capable of carrying out, it was necessary in the first place, to obtain such in a corresponding number of normals. It was in the course of these preliminary tests on normals that certain unexpected points were noted in the records. As they promised to throw some light on the purposes of blinking in general, further varieties of tests on normals were carried out. It is with these, and their results, that this paper is chiefly concerned. In all the tests three important principles were complied with: (i) All the persons tested were unaware that their blinking was being watched. This was secured by various mild deceptions.

(ii) In each test the surroundings and procedure were the same for all.

(iii) All stimuli capable of causing local reflex blinks were excluded.

* Received for publication, June 15, 1945.

† The term blinking, is used throughout this article to mean those acts of bilateral closure of the eyes, which, though slightly variable in duration, are never more than momentary.[4]

PART I—EXPERIMENTAL

Test 1—Rate of blinking in encephalitics as compared with that of normals

FOR this and for Test 2, the examinee and the two observers were seated on three sides of a square table, on which was the Mackenzie polygraph. Observer (A) watched the blinks and recorded them by means of a rubber teat connected with one of the levers. The teat was held out of sight under the edge of the table. Observer (B) worked the polygraph, and directed proceedings generally. The examinees were told that it was their "rate-of-breathing" that was being tested, and to re-inforce the suggestion, a broad canvas belt was fastened round the chest, from which an insulated wire passed to the supporting arm of the polygraph! The arrangement in both parts of the test were such that Observer (A) was able to see every blink, without the examinee's knowledge. The test consisted of two parts; reading a short story *aloud*, and, secondly, talking to observer (B). *Reading aloud* ensured that they were reading continuously, and not merely thinking about something else whilst gazing at the book. In this paper the word reading always means reading aloud.

Altogether 57 encephalitics and 57 normals took part in this test. Of each there were 37 males and 20 females. Twenty-eight of the encephalitics, owing to their various disabilities, could not carry out the reading test. Most of these were the more advanced Parkinsonians, in whom the average rate of blinking when in conversation was only one half that of the others; in seven of them it was less than two per minute, whilst in one there was only one blink in 5 minutes.

The rates obtained were as follows:—

Conversation period	Average blinks per minute M. & F.	M. only	F. only
57 Normals (M. 37, F. 20)	25·4	29·3	18·3
57 Encephalitics (M. 37, F. 20) ...	10·6	11·5	8·8
Reading period			
29 Normals (M. 17, F. 12)	3·29	3·57	2·58
29 Encephalitics (M. 17, F. 12) ...	2·9	3·9	1·4

From the above figures it would appear that there is some fundamental difference between the blinks when in conversation, and those when reading aloud, and that the attack of encephalitis has

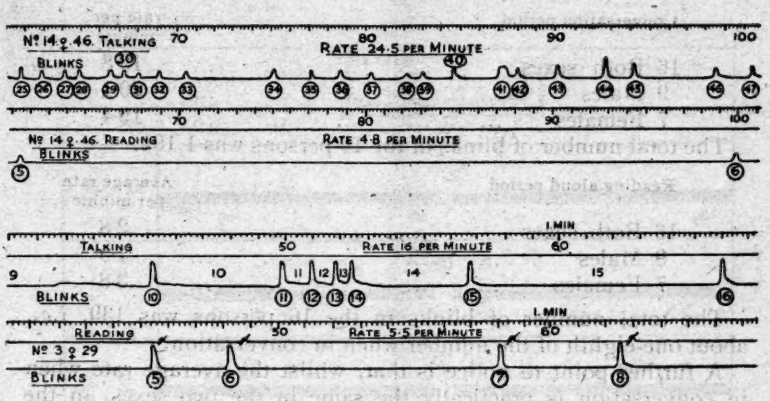

PLATE 1.

Test 1. Parts of original polygraph records of blinks in two normal females, showing, above, when in conversation with strangers, and below, when reading aloud under the same conditions and surroundings. Time-marker, 1/5th seconds.

reduced the number of the former whilst not materially affecting the latter. The remaining tests are limited to persons in normal health.

Test 2—The places at which blinks occur in Normals when reading aloud

In the previous test it had been frequently noticed that a blink occurred at " turning-over-the-page," whilst others coincided with " ends-of-sentence " or other punctuation-marks. In order to confirm these findings further tests were made on Normals, in which the exact times of these " events " were recorded on the polygraph alongside the blinks, by means of the second lever. This was connected with a rubber teat held out of sight by Observer B. The matter read was the same short fairy story as in Test I. The book was post octavo size, with lines $3\frac{1}{2}$ inches long. The story contained 660 words, printed on the two sides of one page, so that there was one " turn-over " about half way through. Everything was carried out exactly as in Test I except that a period of, what may be called, " trick-reading " was added to the other two periods, as will be explained shortly.

Sixteen normal adults (M. 9, F. 7) were examined, all of whom were complete strangers to the place and to the Observers.

The following were the average rates of blinking in the two periods, as in Test I :—

Conversation period	rate per minute
16 Both sexes	19·8
9 Males	20·1
7 Females	19·4

The total number of blinks of the 16 persons was 1,191.

Reading aloud period	Average rate per minute
16 Both sexes	2·8
9 Males	1·5
7 Females	3·8

The total number of blinks in the 16 persons was 139, *i.e.*, about one-eighth of the number when in conversation.

A further point to notice is that, whilst the average rate when in conversation is practically the same in the two sexes, in the reading aloud period the average rate in the females is considerably more than double that in the males. This is directly connected with the greater efficiency of the females as "readers." Indeed the 16 examinees could be placed in three classes as readers: (A) Good, (B) Average, and (C) Bad. In (A) there were six (F. 5, M. 1), in (B) six (F. 2, M. 4), whilst the four in (C) were all males.

Grouping of blinks when reading

The 139 blinks could be grouped as regards the places at which they occurred into three categories, as follows:—

(i) At turning-over-the-page	12
(ii) At punctuation marks	118
(iii) At other special points	9
	139

Omitting (iii) for detailed consideration later, it is seen that whilst the blinks of (i) are at a "physical" gap in the matter read, which calls for a change in the direction of fixation to a point at the moment out of sight, yet in the much larger number of (ii) no such change of direction is required. When the blink is over fixation is resumed at the same point.

The blinks of (i) and (ii) were much more numerous in the readers of Classes A and B, the good and the average, than in Class C, the bad. In three out of the four last-named there were no blinks at all during the whole reading-period. That there is an essential difference between the blinks at physical gaps in the text, and those at punctuation marks (blinks of "technique") was made clear by a form of "trick-reading," as follows:—

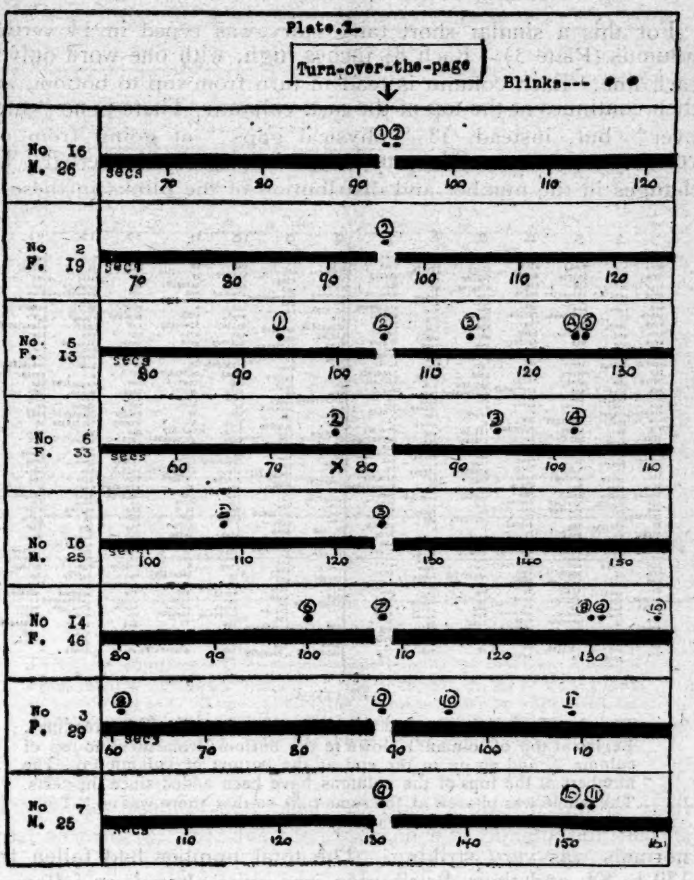

PLATE 2.

N.B. In this and in Plates 4, 5 and 6, the polygraph tracings have been compressed so as to show more of their length or the whole length. The time is shown as a straight black line with the number of seconds in figures above. Blinks are shown as "dots" with or without a circle around them.

Test 2. Parts of compressed polygrams from eight persons (normals) showing blinks at "turning-over-the-page" when reading aloud. The blank in the time line corresponds with the turn-over in each person. No. 6. In this very good reader, her blink (marked x) did not occur at the actual turn-over, but about 3 seconds before, at the moment at which she took hold of the bottom corner of the page, raising it slowly before turning it quickly, as she finished the page. This was probably a blink of technique, rather than "at-a-physical gap."

Reading-down-in columns (trick-reading)

For this a similar short fairy story was typed in 14 vertical columns (Plate 3). Each 8½ inches high, with one word only in each line. Each column is read in turn from top to bottom, and then continues at the top of the next column. There is no "turn-over" but, instead, 13 "physical gaps" at going from one column to the next. The punctuation marks are all inserted. The changes in the number and distribution of the blinks in these 16

PLATE 3.

Test 2. Typed script used for "Reading down" (Trick-reading). Begins at top of column 1, down to the bottom; from there to top of column 2, and so on to the end at the bottom of column 14. The numbers at the tops of the columns have been added since the tests. The whole was in view at the same time so that there was no "Turn-over."

normals was very striking. The total number had fallen from 139 to 88, and their distribution was quite altered, as follows:—

Category	No. of Blinks
(i) Gaps at changing columns	69
(ii) Punctuation marks	16
(iii) Other special points	3
	88

Thus with the increase of "gaps" from 16, at turn-over, to 208 at column changes the blinks of (i) had gone up from 12 to 69. With the novelty of the setting the blinks of "technique" had fallen from 118 to 16.

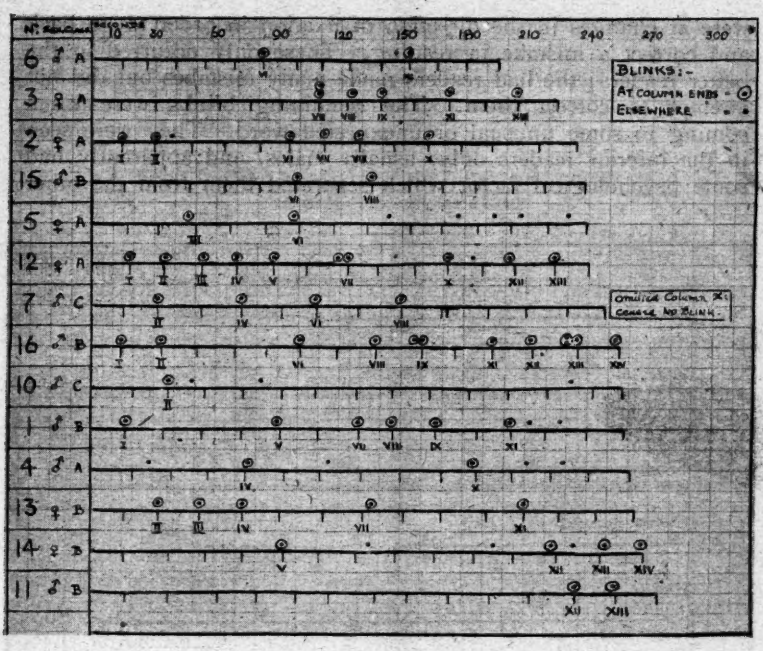

PLATE 4.

Test 2. Compressed polygrams (whole-length) of fourteen normals when reading-down in columns. Class of reader, A, B, or C, is given alongside the sex. Time of changing column shown as short vertical lines from horizontal time-record. Blinks at column changing down by dot with ring round; blinks at other places by dot only. Time in seconds shown above.

The better readers had been completely thrown out of their stride, as readers, and, *quâ* the observance of punctuation marks, reduced in technique to the level of the inferior classes. That is to say, they ignored most of them.

Reading-down period	Average rate per minute
16 Both sexes	1·3
9 Males	1·0
7 Females	1·6

Total number of blinks: 88.

The blinks of category (iii) when reading (ordinary text)

One of the nine was an "Aural-reflex blink," caused by a sudden noise (interruption from without). Four of the remainder

were at changes in the direction of fixation in order to go back and correct a mistake in reading. These only occurred in the better readers; the bad readers made many mistakes but did not attempt to correct them. The remaining blinks were when coming to some unusual or unexpected word. They were seen in the inferior readers only, usually males, and apparently had some psychological factor which separated them from the other

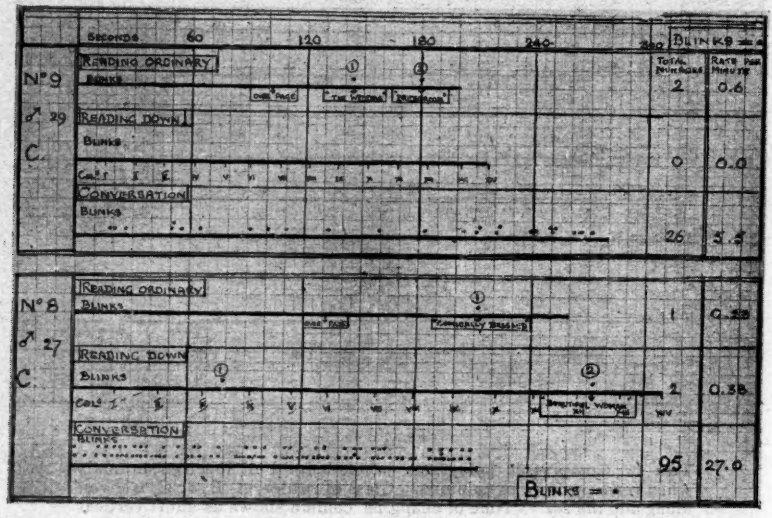

PLATE 5.

Test 2. Compressed full length polygrams of two normals, both inferior readers, class C, and young males. Each is recorded when reading-aloud (ordinary), reading-down, and in conversation. Note the extreme rarity of blinks in either form of reading, their absence at "turn-over" and their occurrence at special words. Also the wide difference of rate when in conversation.

groups. Some of the words had a certain "sex-association." One was "The Queen," another "Beautiful woman." One man blinked first at the words "for the wedding" and later, at "Again the Bridegroom."

Physical gaps.—As regards the question of what constitutes a "gap" sufficient to call for a blink, it is evident that the end of one line to the beginning of the next below *does not*, either in post-octavo size, or, as is well-known, in much larger sizes. If, however, the lines are much longer, blinks may occur at their ends. This was demonstrated in one male, the only person tested in this way. The same story was typed in Brief-form,

with lines 18 inches long. In reading this he blinked at the end of 6 out of the 22 lines, although when previously reading from the post-octavo book he had not blinked at the end of any. His ocular automatism for reading had not been trained for such long changes in the direction of fixation.*

Test 3—The relation of blinking to changes in the direction of fixation

For this the examinee was seated facing the observer, about five feet away. As it was obvious that his eyes were being watched, each person was told that the accuracy of sight, under exceptional conditions, was the subject of the investigation.

Fifty normal adults (M. 17, F. 33), none of whom had taken part in either of the two previous tests, were examined in the following three ways :—

(A) With fixation maintained on a centrally placed object whilst it is moved from side to side.

(B) With fixation changing in direction from one central stationary object to other stationary objects, on his right and left.

Each of the above was done in two parts (i) with head *free*, and (ii) with head *held*, by the Nurse, who placed the palm of the hand on each side of the examinee's head, and held it firmly.

(C) With fixation maintained on a central object which remained stationary, whilst the examinee rotated his head freely to right and to left.

Results of (A)

The object to be looked at was the upheld finger of the Observer whilst it was moved horizontally to and from the extreme right and left.

Results

(i) Head-free.

	No. of persons	No. of blinks
	1 (F.)	2
	2 (M. 1, F. 1)	2
	47 (M. 16, F. 31)	0
Totals	50	4

The female who blinked twice was very nervous.

(ii) Head-held.

	2 (M. 1, F. 1)	2
	48 (M. 16, F. 32)	0
Totals	50	2

* My grateful thanks are due to the out-patient sister at the Sheffield Royal Hospital, Miss Milton, who as observer (A) was responsible for the recording of the blinks throughout Tests 1 and 2.

The two who blinked here had not done so with head free. None of the 6 blinks occurred at points where the direction of movement of the object was being changed.

Results of B

The stationary objects were three large cards hung on the wall behind the Observer, and about seven feet from the examinee. No. 1 was in the centre, Nos. 2 and 3 on his right and left respectively, about seven feet apart. He was asked to look first at No. 1, then at No. 2, then back to the central, 1, then to 3 and back again to 1. There were thus *four* changes in the direction of lateral fixation. The important instruction was added that none of these changes should be made until *told by the Observer to do so.*

Results

Changes in direction of fixation at which a blink occurred	Number of persons (i) Head-free	(ii) Head held
At Four	21 (M. 7, F. 14)	12 (M. 3, F. 9)
At Three	7 (M. 2, F. 5)	5 (M. 0, F. 5)
At Two	9 (M. 4, F. 5)	4 (M. 0, F. 4)
At One	6 (M. 2, F. 4)	11 (M. 6, F. 5)
At None	7 (M. 2, F. 5)	18 (M. 8, F. 10)
	50	50

It is seen that, with head-free (i), more than four-fifths blinked at one or more changes in direction of fixation, of whom nearly a half did so at every change, whilst, in nearly one-fifth, there was no blink at any. With head-held (ii) the blinks were reduced considerably in some, in others, not at all. In the seven who did not blink in (i), there were again none in (ii). On the whole the effect of holding the head reduced the rate of blinking rather more in the males than in the females.

N.B.—In a further short series of normals these tests were repeated with the head rigidly fixed in a metal clamp for (ii). The results were practically the same as above. One man who had blinked at all four changes with head-free, did the same with head-clamped; another did not blink at any change, either with head-free or clamped.

Results of (C)

For this the object on which fixation was to be maintained was, as in (A), the finger of the Observer held straight in front of the examinee a few feet away, but whereas in (A) it was moved from

side to side, here it was kept stationary, whilst the examinee was asked to turn his head first to one side then to the other, whilst still keeping his eyes on the finger.

N.B.—So intimately associated is the lateral movement of the head with that of the eyes, that several found it difficult to keep the eyes fixed on the object as soon as they got the head moving to the side. In such it was more easily done, and produced a perfect result if they were told to *move the chin* laterally as far as they could whilst looking at the finger. The result, quâ movement of the head, was the same.

Results

In 38 (76 per cent.) out of the 50 there was no blink throughout. Of the remaining 12, one nervous woman blinked four times, but none of them were at any point where there was a change in the direction of movement of the head. In most of the other eleven, each of whom gave one blink only, this was usually at the return from the extreme end, or when passing the middle point and going to the other side. One man moved his head with such freedom and vigour, on going to the right, that he overshot the position at which the object was still visible, and had to blink to bring it in view again.

No. of persons					No. of blinks
38	(M. 11, F. 27)	gave no blinks	...	...	0
11	(M. 6, F. 5)	gave one blink	...	...	11
1	(F. 1)	gave four blinks	...	...	4
50					15

Test 4—Blinking in the blind

Polygraph records were made of the blinking in three children, two brothers, congenitally blind, and another boy, nine years old, totally blind since five years of age. Each boy was in conversation with a stranger, during the whole period of the record, the conditions being similar to those described in Test I. Their respective rates differed, from 22·5 blinks per minute to 7·5. The accompanying Plate gives the distribution of the blinks and alongside each, for purposes of comparison, is the record of one of the normal series from Test I, whose blinking was at about the same rate. In the distribution of the blinks, the records of the blind are indistinguishable from those of the normals.

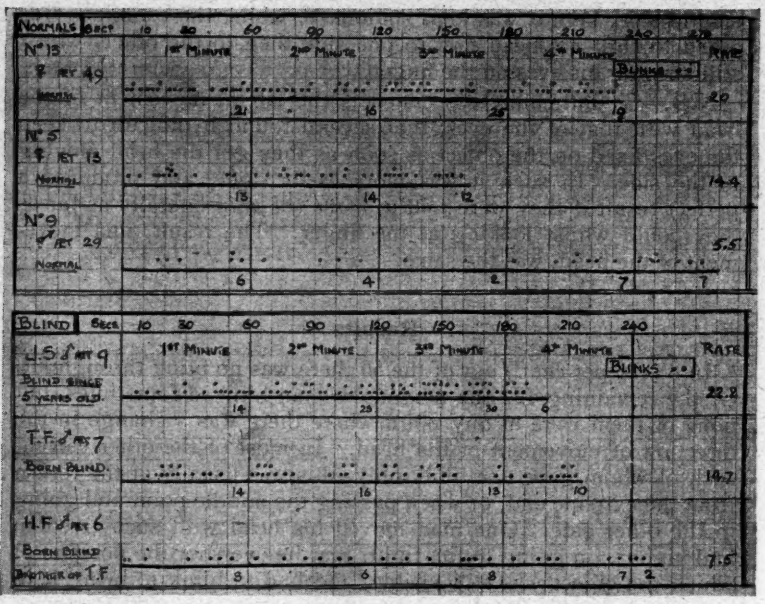

PLATE 6.

Test 4. Compressed full length polygrams of three blind boys when in conversation with a stranger, and of three normals under the same conditions. Each of the latter has been chosen as comparable in rate with one of the three blind. One of the latter, H.F., is certainly of congenital origin, whilst his brother, T.F., is practically so.

Name	Age	Sex	Vision	Rate per minute	Blinks in successive minutes					
					I	II	III	IV	V	VI
H. F.	6	M.	Blind (congen).	7·5	8	6	8	7	2 ($\frac{1}{4}$ min.)	—
No. 9	29	M.	Normal	5·5	6	4	2	7	7 ($\frac{1}{4}$ min.)	—
T. F....	7	M.	Blind ? congen.	14·7	14	16	13	10 ($\frac{1}{4}$ min.)	—	—
No. 5...	13	F.	Normal	14·4	13	14	12 ($\frac{3}{4}$ min.)	—	—	—
J. S. ...	9	M.	Blind at 5 years	22·2	14	23	30	6 ($\frac{1}{3}$ min.)	—	—
No. 13	49	F.	Normal	20·0	21	16	25	19 ($\frac{5}{6}$ min.)	—	—

Valued help in obtaining the above was given by the Superintendent of the Sheffield School for the Blind.

Since these records were made, Dr. A. B. Nutt, Medical Officer to the School, has obtained the aural, or acoustic, reflex blink in one of the congenital blind boys (H.F.). This has such an important bearing on the aetiology and purpose of blinking that it will be dealt with more fully in a later section.

Summary of tests

Test 1.—The average rate of blinks per minute in the chronic encephalitics, when in conversation (10·6), was less than half that of the normals (25·4), yet when reading aloud the rate in the two groups was practically the same (encephalitics 2·39, normals 3·29).

Test 2.—When reading aloud most of the blinks occur at certain points in the text, either (*a*) at " physical gaps " in the print requiring a change in the direction of fixation, or (*b*) at marks of punctuation, calling for slight pauses in the flow of words, to express the meaning of what is being read. These are part of the acquired " technique." The difference between these two groups of blinks was emphasised by an unusual way of setting the type in vertical columns instead of horizontal lines (reading down).

Test 3.—So long as fixation on an object was maintained (watching), there was no blink in more than 90 per cent. of normals* either (i) when the object and the head were both stationary and the latter free or held, or (ii) when the object was stationary but the head free and rotated from side to side, or (iii) when the object was moved from side to side, and the head free or held.

On the other hand, when the stationary objects were multiple and separated at a distance from one another, so that the direction of fixation had to be changed on looking from one to another (looking about), a blink occurred *at the beginning* of the change of direction in 86 per cent. of the normals when the head was free, and in 64 per cent. when the head was held. In 14 per cent. there was no blink at change of direction of fixation under either condition of the head.

Test 4.—In three blind children, when in conversation with a stranger under the same conditions as in Test 1, blinking occurred, the records of which, in appearance, frequency and grouping, were indistinguishable from those of normals. The aural or acoustic-reflex blink was observed in one of them, a congenital-blind boy.

* In the rather complicated and varied requirements of Test 3, some of the examinees got confused and nervous, and blinked at odd times. This was especially so in part (ii) where the head only is turned, the eyes fixed on the object.

PART II—VARIETY OF BLINKS IN MAN

Blinks may be either voluntary (Group A) or reflex. The latter, with which this paper is alone concerned, may be placed in at least three distinct Groups (B), (C) and (D).

Reflex or automatic blinks.—Group (B). These are solely for the protection and efficient action of the eyes themselves. Of them the chief are the "corneal- or tactile-reflex" and the "dazzle-reflex," each of which is only aroused by appropriate external stimuli. They are often prolonged until the nocuous stimulus is got rid of.

With these may be included certain blinks described by Duke-Elder[3] and others, which aid the circulation of the intra-ocular fluids.

The old view that there are special blinks for keeping the surface of the eyes moist seems improbable. Ponder and Kennedy[9] in their experiments found no increase of blinks in the hot dry atmosphere of the Turkish bath, and, as is well known, the eyes of the chronic Parkinsonian do not become unduly dry, though he may, for years, only blink once every two or three minutes. Undue dryness at any time is probably dealt with by the corneal, or tactile-reflex.

Group C.—These are for the preservation of the organism as a whole, and are in no way concerned with the efficient action or protection of the eyes themselves. They form the majority of the blinks in daily life. They are so brief that they do not interrupt vision, and we are unaware of their occurrence. Ploman, Engel and Knutson[8] give 0·4 secs. for the total duration, with 0·15 secs. for the complete covering of the pupils. They vary in frequency and purpose, according to circumstances.

Group D.—These are blinks of "technique," seen in the special act of reading aloud. They are conditioned reflexes acquired in the training for this art. They vary in duration with the requirements of the text, and the taste of the reader. They are seen at the marks of punctuation.

It is with the blinks of Groups C and D that this paper is alone concerned.

Purposes of blinks in Group C

Seeing that blinks, indistinguishable from those in man, occur to a variable extent in most vertebrates, a review of what is known as to their occurrence in these latter, living under more simple and primitive conditions may help to explain their purposes in the former. The primary object of every living thing is to reproduce its kind. For this it must obtain food and avoid being killed.

The carrying out of these two functions, is of such importance, that it is ensured by involuntary unconditioned reflexes.

In all animals there are two such inherited unconditioned reflexes which Chavasse[2] calls that of "Aggression" and that of "Self-preservation" respectively. They are opposed, and cannot both be in action at the same time. The extent to which each is required, and used, differs in different species. In the carnivora, or "hunters," aggression, *i.e.*, attack, is their sole means of getting food, which is usually at a distance away, mobile, and actively resistant. On the other hand, to them, the reflex of self-preservation is of much less importance. Attacks from other carnivora are but rare, and are often met by active resistance rather than by flight.

In the Herbivora, or "hunted," it is the reverse. Their food calls for no aggression; it is close beside them, stationary, and non-resisting. On the other hand self-preservation, either by hiding or by flight, is of constant and paramount importance to save them from their carnivorous fellows. This is attained by Pavlov's[7] Investigatory or Where is it? reflex; "If the animal were not provided with such a reflex its life at every moment would hang by a thread." In each of these unconditioned reflexes all the receptor, or sense-organs, act together as one, in order to give the fullest information to the nerve centre as to its surroundings. Whilst in some animals, the senses of smell and of hearing are more informative than they are in man, yet in most, as in him, the eye is the receptor of primary importance. It is the part which the eyes take in these two opposed reflexes which closely concerns the blinks of Group C, because, for each, they must be differently "adjusted," and these two adjustments cannot be in action at the same time. As Holmes puts it,[5] "There are two distinct and *opposed* (italics ours) cortical ocular reflexes, the one, which is excited by extra-macular stimuli, effects movements of the eyes; the other, of macular origin, holds an object in central vision, either by maintaining the posture of the eyes, or by moving them appropriately when, either the object, or the subject's head, moves in space."

Of these two ocular reflexes, the extra-macular, when in action, is receiving stimuli from every point in the field of vision, whilst so long as the macula is acting, only such stimuli as fall on that small portion of the retina which is differentiated from the remainder of it are reaching the nerve-centre with full intensity. In other words the area of the field of vision has been reduced in size, but increased in visibility; the "high-power" has, for the time, replaced "the low-power" objective. Whilst below the level of the primates the macular reflex (true fixation) is not fully developed, yet in all vertebrates there seems to be some, even if

but slight, special differentiation of the retina in its temporal part (Chavasse[2]). With this proviso the terms macular and fixation will be used here as synonymous.

The extra-macular is the more primitive in origin, of more vital importance for self-preservation, and, even in man, the master-reflex of which, from the first, fixation has been the servant, to be called to action, or dismissed, as its master requires. As James[6] puts it, " The main function of the peripheral parts of the retina is that of sentinels, which, when beams of light fall over them, cry ' Who goes there? ' and call the fovea to the spot."

In the lower animals it is only, as in the carnivora, for purposes of aggression, that the fixation reflex is kept in action for long periods when watching their prey. Indeed this association between prolonged " watching," or " staring without blinking " and the carnivore is recognised in many familiar expressions, such as, " He stared at me as though he wanted to eat me!" or the simile " Like a cat watching a mouse!" In the herbivora, on the other hand, prolonged fixation is rarely required. If the object is an enemy, the head is at once turned away, and immediate steps are taken to escape danger; if it is not, interest in it soon ends and fixation ceases, because so long as high-power objective is on, the eyes are not in action for self-preservation.

As will be shown in the following section the rate of blinking in the carnivora is much lower than that in the herbivora.

Blinking in the lower animals

Blount's[1] observations, at the Edinburgh Zoo and elsewhere, show that in most of the lower animals, blinking occurs which is indistinguishable from that seen in man, but at an average rate lower than that seen at the level of the primates. If the rates that he gives are separated into those of the herbivora and those of the carnivora respectively, it is found they are considerably higher in the former than in the latter. Thus:—

Rates of blinks per minute

Herbivora		Carnivora	
Goat	2	Cat	less than 1
Alpaca	2	Lion	less than 1
Bison	6	Dog	2
Camel	8	Leopard	2
Deer	10	Fox	less than 4
Elephant ...	16		
Horse	20		
Cow	22		
Average ...	10·5	Average	less than 2

This difference in rate of blinking in the two groups corresponds with the relative importance to each of self-preservation and aggression respectively, and is accompanied by a different "setting" of the eyes in the head. In the herbivora they are more lateral in order to give the widest possible field of vision, especially to their defenceless rear; in the carnivora they are looking more forward so that the prey in front of them may be more easily watched.

Chavasse[2] gives the following figures for the angle gamma, in the two groups:—

Herbivora	from 80° in the Hare, to 40° in the Pig.
Carnivora	from 45° in the Dog, to 10° in the Lion.

The fact that the blinking-rate is higher in the "hunted" than in the "hunting" animal suggests that its purpose is connected with the self-preservation reflex.

This is confirmed by the occurrence of two well-recognised reflex blinks, seen in the lower animals at "threats of alarm."

These are:—

(*a*) The aural- (or acoustic) reflex blink.

(*b*) The menace-reflex blink.

The former (*a*), follows an unexpected or strange sound from near or from afar. Blount[1] saw it in the elephant at hearing the click of his stop-watch.

The latter (*b*), follows the sudden appearance of some threatening object in the near field of vision. Rademaker and Garcin[10] produced it in the cat, by a menacing action of the fist.

Both (*a*) and (*b*) are seen in the primates and in man under similar threats of danger.

Blinking in the arboreal primates

Blount[1] gives the following figures:—

Chimpanzee	11·1 (eleven)	per minute
W. Indian monkey ...	13·6	per minute
Sudanese monkey	45	per minute

This gives an average of about 24 per minute which is higher than that in the lower animals.

Such increase cannot be ascribed to a greater need for self-preservation, because, although, as herbivora, they are still "hunted" animals, they have acquired considerable security from their terrestrial enemies by taking to life in the trees. Nor are the primates aggressive although the setting of their eyes, in contrast to that of the lower herbivora, is even more "forwards" than that of any of the aggressive carnivora. Their angle gamma, is only 5 degrees. The fact is that with the setting free

of the forelimbs for purposes other than locomotion, a new use for the fixation-reflex has become essential in order to guide and control their movements in all the many purposes to which they are applied. For these, fixation is no longer the long-continued "watching" of aggression but constant changes in direction according to the nature of the action in progress. Together with this, vision has become binocular and stereoscopic; convergence has been acquired, and the macula further developed. In this new use of the fixation reflex, the eyes are to an increasing degree, acting independently of the other receptive organs, except the sense of touch.

Further, the primate has begun to take an active interest in its surroundings apart from what concerns self-preservation and food. It has begun to "look-about"; the curiosity of the monkey is proverbial! Although there is a direct connection between these new uses of the eyes and the increased rate of blinking, yet the old primitive blink of the self-preservation reflex, in association with the other sense organs, still remains exactly as in the lower animals. The aural or acoustic reflex blink was seen by Blount[1] in the Sudanese monkey, as in the elephant, at the click of his stop-watch.

Two further points of interest were also observed by him in the arboreal primates: (i) The rate in the chimpanzee rose from eleven to twenty-four per minute on the approach of its keeper, and (ii) in the Sudanese monkey it rose from 45 to 75 per minute when the animal was, purposely, teased. As will be shown later, these latter results are closely similar to those obtained in man.

Blinking in man

The rate of blinking in man varies so widely in the same person under different surrounding circumstances that it is difficult to speak of an average rate, without giving the circumstances at the time. Thus, whilst Ponder and Kennedy[9] found an average rate of 16 per minute in 100 persons sitting in street-cars; that of 57 normals (recorded in Test 1) when talking with a stranger was 25·4, whilst when "reading aloud," under the same surroundings, had only been 3·29 per minute. On the whole it is greater in man than in the lower animals and closely similar to that in the arboreal primates. As in them, the eyes are used to guide the many further uses to which the hands have been applied by man in the development of the various arts and handicrafts from which civilisation has been evolved. For all this the independent use of the fixation-reflex in constantly changing directions has become increasingly essential, in order to meet the needs of the particular action in progress at the time. During this the extra-macular

reflex, for purposes of self-preservation, is necessarily out of full action, but it still remains in its primitive ancestral form and, at any moment, should danger threaten, is ready to shut off fixation by a blink, and to assume control in co-operation with the other sense organs. Thus, in Test 1, the aural or acoustic reflex blink occurred in no less than three of the normals when reading aloud. It followed a sudden ring of the telephone in one person and loud knocks at the door in two.

Further, the menace-reflex can be produced in man, as in the lower animals by suitable means. Rademaker and Garcin[10] produced it, in man, under the same conditions as in the cat, but failed to do so in the first few months of human infancy, " Ce réflex manque . . . ' dans les premiers temps que suivent la naissance '."

Until binocular vision and fixation have been acquired the rate of blinking in the human infant is not greater than that of an adult lower animal.

On the other hand there is ample evidence that at the level of the primates and still more in man, blinks closely allied to, but of less urgency than, the aural or menace reflexes, frequently arise from internal, emotional or nervous causes, that is, from imaginary, rather than real, threats. As was seen in Test 1, the average rate of blinking in the normals went up from 3·29 when reading to 25·4 when in conversation with a stranger; Ponder and Kennedy[9] found the rate go up from 12 to 20 per minute in a witness in Court when coming under cross-examination, and, further, state[9] that they found the rate trebled in a man whom, for experimental purpose only, they had made angry. This agrees with Blount's[1] findings in the Sudanese monkey when teased.

Blinking in the blind

In addition to the voluntary blinks of Group A, and those for the local protection of the eye itself, Group B, blinking occurs in the blind, even when congenital in origin, indistinguishable from that of Group C in normal persons. This was the conclusion come to by Ponder and Kennedy[9] in their examination of over 200 blind persons, and it is confirmed by the records given in Test 4.

Further, it is now known that the aural or acoustic-reflex blink occurs in the congenital-blind at a sound of alarm exactly as it does in other vertebrates, and in man with normal sight. This has been demonstrated, since the polygraph records were made in the boy, F.H. (aged 6 years), by Dr. A. B. Nutt, medical officer to the Sheffield Blind School. He obtained it by making a sudden loud bang on the door, whilst keeping the boy in conversation.

This original observation shows that, even in the congenital-blind person in whom the act of fixation has never taken place, the eye still retains its place in the nerve-centre alongside the other sense organs for purposes of self-preservation. When danger threatens, orders are transmitted to it to take its part just as if it were fully capable of so doing. The only part that it can carry out is to "clear the decks for action" by a blink, as its ancestors have done for countless ages.

The purposes of blinks in Group C

The immediate purpose of every blink in this Group is to cut short the fixation reflex,* without interrupting the continuity of vision. It is the automatic shutter by which the controlling nerve-centre puts the extra-macular reflex into full action.

This may be either (1) for the purpose of self-preservation, or (2) in order to change the direction of vision.

(1) For self-preservation the extra-macular reflex blink is needed: (*a*) When there is a warning of real and immediate danger to life, as in the aural and menace reflexes. These are seen throughout the animal kingdom, and are a part of a primitive, inherited, unconditioned reflex, in which all the receptors act together in close co-operation. The blink is the first of the many duties of the eyes when danger threatens; in the human congenital-blind it is the *only* one which they can carry out normally.

In the comparative security of civilised life, the blinks of this sub-group are less required than in animals living in the state of Nature. They are the more readily elicited the more deeply fixation is "set."

Much more common in man, but seen also in the lower primates, are blinks of similar type which may be classed as Sub-group (*b*): Here the warning is not of immediate danger to life, but of something to be feared from the surrounding conditions, sufficient to warrant the receptor organs to be on the alert. These are the blinks seen in states of nervousness, emotion or excitement. Their frequency and their occasions vary widely with the individual's "make-up." They form a large proportion of the blinks in the every-day life of man. The fact that a sense of "loneliness amongst strangers" is often a factor suggests the ancestral fear

* That a closure of the lids does cut short the fixation-reflex, even when "spasmodically set," has been shown by Gordon Holmes ([3]) in a man with "spasm of fixation," who, once he had fixed his eyes on an object, could not take them off again. The shutter had ceased to function *automatically*, owing to disease. If, however, "fixation was broken by placing a screen in front of his face, *or by blinking* (italics ours), his eyes at once slid back."

of " separation from the herd." The increased blinking of persons in conversation with strangers (Test 1), or of the witness under cross-examination, or of the person made angry belong to this Sub-group. They are inherited reflexes conditioned by various unwritten laws and convenances, of which civilised society demands the observance.

As Nutt has shown that blinks of Group 1 (*a*) occur in the congenital-blind, it is reasonable to infer that they have blinks of sub-group (*b*) also, given the surrounding conditions which produce nervousness or emotion in persons with normal sight.

The blinks of this sub-group (*b*) are fewer in the chronic encephalitics (Test 1); in whom loss of the emotions, or loss of expressing them, is so striking a feature. Their reduced rate of blinking is also to be attributed to the muscular rigidity which prevents them from " looking-about " (Group 2).

Group (2). *To change the direction of fixation.*—Whilst the act of changing the direction of vision is one of the primitive functions of the extra-macular reflex, and of vital importance in the reflex of self-preservation, the increased, and more recently acquired, independent use of fixation for looking-about, and for guiding the movements of the hands calls for changes in direction of vision far more frequent than those required in the lower animals. As was shown in Test 3, they form a large proportion of the blinks seen in man, when asked to look from one point in space to another. Apparently, in most persons this is done by shutting off fixation, so that the change can be made by the extra-macular reflex, but this is not so in all, or at every change.

Possibly the distance apart of the two objects, or the uncertainty as to the exact position in space of the second play some part in this difference of procedure. Possibly, also, some few persons have acquired the habit of moving the eyes, so-to-speak, " on the fixation-reflex " for long distances, just as everyone does for short ones as when reading from word to word or from line to line. As was shown in Test 2, a few blinks when reading aloud, did come under this Group 2, as when " turning over the page."

These blinks do not occur when fixation begins on the new point, nor so long as it continues there, but only at the moment when it has to be ended in order that the extra-macular reflex may move it elsewhere.

It must not be inferred from the above that a blink is always necessary to bring the act of fixation to an end. On the contrary it is probable that it usually ceases especially in the lower animals by a mere relaxation of the muscles as does any other muscular action. Probably the only times when the automatic blink is called for in order to cut fixation short, is when the call for the

extra-macular reflex is more or less urgent, or when fixation is more deeply and independently "set" as it often is in the primates.

Purpose of blinks in Group D

These form the bulk of the blinks in the special act of reading aloud, and are indeed "blinks of technique," the purpose of which is to interrupt the visual incoming of the written word in order to delay its outflow in speech. Their duration varies with the marks of punctuation of the text, at which the blinks of this Group mostly occur. They differ from the blinks of Group C in that they *do interrupt vision,* for just so long as the accomplished reader thinks desirable. They are not followed by any change in the direction of fixation, which resumes at the same point at which it was before. Probably they were begun, in the first instance, as voluntary closures of Group A, but in the course of training, they have become, in the accomplished reader, conditioned reflexes. As was stated above (Test 2) some few of the blinks when reading aloud belong to Group C (2), and are for the purpose of changing the direction of fixation. That the "blinks of technique" are not of "nervous" or emotional origin is shown by the fact that, unlike those of Group C (1) they are not reduced in number in the chronic encephalitics (Test 1).

Conclusions

Apart, and distinct from, those reflex blinks seen in animals and man which are solely for the local protection and efficient action of the eyes themselves (Group B) every blink in man is the muscular act by which the controlling nervous centre automatically shuts off the act of fixation in order to put the extra-macular reflex into full action. (The purpose is slightly different in the blinks of Group D.)

The reasons for the blinks may be:—

1. *For self-preservation,* either from a threat of real danger to life coming from without through any of the sense-organs, or from undefined fears aroused by the surrounding conditions at the time. The former, Group C, I (*a*), is the primitive unconditioned reflex seen throughout the animal kingdom; the latter, Group C, I (*b*), is probably of the same origin but conditioned in the primates by the increased security of arboreal life and in man still more, by the requirements of civilisation. They form a large proportion of the blinks in everyday life.

2. *To change the direction of fixation.* (Group C, II).—Whilst some are but a part of the orientation of the head and eyes

in the self-preservation reflex, far more, especially in the primates, are either for " looking about " or to aid the various purposes for which fixation is used independently.

3. *To make pauses in the act of reading aloud.* (Group D.)—These are conditioned reflexes acquired by training.

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WORD BLINDNESS: ITS CAUSE AND CURE*

BY

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DR. ORTON'S book " Reading, Writing and Speech Difficulties in Children " may be regarded as a standard work on word blindness. It seems, however, to do little more than describe this complaint without pointing to an effective remedy.

Dr. Orton records that Hinshelwood in 1917 produced a monograph on this subject in which it was asserted that word blindness was not due to defective vision. Hinshelwood, however, drew attention to two facts, namely (1) several cases of word blindness often occur in one family and (2) that symptoms displayed are very similar to those of adults who have lost the capacity to read because of brain injury, *i.e.*, damage to the angular gyrus of the dominant hemisphere. He therefore assumed a congenital defect of development of this area of the brain in word blind children.

Dr. Orton points out that there is no subsequent evidence to support this hypothesis as such areas of agenesis are rarer in the general autopsy service than is word blindness in children.

* Received for publication June 11, 1945.

Moreover as only one hemisphere is required for reading, and with children if one were damaged the other could probably be used, such areas of agenesis would to be operative require to be on both sides of the brain which is still rarer.

Summing up the position, Dr. Orton writes " Obviously there are multiple causes for a delay in learning to read " such as defects in vision, defects of hearing, general intellectual defect, and emotional disturbances. *" When, however, all such factors are excluded there remains a group of very considerable size in every school who have shown no evidence of any delay or abnormality in either their physical, mental or emotional development until they have reached school age and are confronted with reading and then they suddenly meet a task which they cannot accomplish."* He continues, " Functions other than reading but which incorporate a visual element are usually entirely normal. Visual recognition of objects, of places and of persons is quite normal, and interpretation of pictorial and diagrammatic material is frequently very good." Dr. Orton further points out that his experience acquired from visiting many schools shows that word blindness is the greatest scholastic handicap to otherwise normal boys as it prevents them making the grade necessary to enter a University or at times even merely a middle school. He further points out that with such children " spelling forms an almost insuperable obstacle."

While pointing to these very serious handicaps, Dr. Orton seems unable to suggest any more concrete method for overcoming word blindness than that which a more individual and sympathetic tuition of the boy or girl concerned may afford.

Having suffered from word blindness as a child and, incredible as it may seem looking back, being unable to read up to the age of fifteen (*i.e.*, prior to puberty. Did one's altered thyroid functioning have something to do with this change?) I can speak from experience when I say what a terrible handicap this is for a child. Although in World War No. 1, I spent over three years at the Front, I can truthfully say that I never during those years experienced a fraction of the stark terror that I did as a boy at school during English lessons lest I should be called upon to read aloud and reveal to the whole class that I could not do so. Every possible device I could I used to kill time so that my turn to read aloud might not come before the lesson ended. I asked every possible question and then every possible question about the answer. Sometimes these tactics just saved me but not always. There must be many children who are to-day living a similar nightmare existence for a child's sensitivity and fear of ridicule are limitless. The lifting of this handicap raised me

from being nearly bottom at school to passing with ease top into a branch of the Civil Service where everyone who passed in below me had taken an honours degree at Oxford or Cambridge.

In my childhood my parents did what they could to help me, taking me to an ophthalmic surgeon who prescribed glasses, but these produced no effect whatever. It was also suggested that I should read words written in very large type but this also proved of no assistance. It was only years later as a young man, when reading Stout's Manual of Psychology, that I stumbled across what I believe to be an explanation of word blindness and a means of cure (although apparently not in any way grasped as such by Professor Stout himself).

The explanation seems to be that a person suffers from word blindness because he has an inadequately developed synthetic vision, at least for such objects as words, and cure seems to be to remedy this by practising analytic vision. This conclusion was arrived at by considering first tactual perception and then visual perception in the case of persons previously blind. In regard to tactual perception Stout writes :—

" It must be understood that the observations and experiments on which we rely are all made on blind persons who have already acquired considerable experience. Their spatial perception is therefore at the outset developed in some measure. What we can observe therefore is only the process by which greater precision and accuracy are acquired. It is fortunate for psychological purposes that spatial perception by touch frequently does not reach full maturity with nearly the same rapidity as spatial perception by sight. Hence, even in the adult blind, it is possible to observe it in the process of growth.

" The chief instrument used by the blind in perceiving the shape and size of objects is the hand, or rather the two hands. (1) The hand either open or closed, may touch simultaneously the parts of the object. This may be called ' passive touch,' because it does not involve active movement from one part of an object to another. It may also be called ' synthetic touch,' because it yields a total simultaneous impression of all or many parts of the object. (2) A portion of the hand, such as the finger-tips, may explore the parts and contours of the object by gradually moving over them. This may be called ' active touch,' because it essentially consists in active movement. It may also be called ' analytic touch,' because it analyses or breaks up into a series of successive impressions what synthetic touch presents as a simultaneous whole. Now the main lesson that we learn from study of the blind is that development in the definiteness of the perception of spatial order is essentially due to the intimate union and co-operation of synthetic and analytic touch."

The above naturally leads to the question, may not development in the definiteness of the perception of letter order, or words, be essentially due to the intimate union and co-operation of synthetic and analytic vision? When we turn from tactual to visual perception we find that this is so, for Stout writes: "The apprehension of tactual space develops through a co-operation of active and passive touch. What we know about children, and about persons blind from early infancy who have recovered their sight by an operation, shows that the same is true of sight. In the case of an operation for congenital cataract, a boy could not count even as few as two objects by means of passive sight, although he had learnt to count by means of touch. When two objects were placed before him, and he was called on to say how many they were, using sight alone, he could do so only by fixing his eyes on each of them in turn. At the outset it was necessary for him to point to each of them successively with the finger. Pointing without touching was sufficient. At a later stage he was able to count merely by fixing his glance on each object in turn. This he did at first not by movements of the eye, but by lateral movements of the head. It was not till much later that he learnt to count a number of objects at a single glance."

Aldous Huxley, in his book, "Seeing Without Glasses," has laid great stress on the fact that *seeing is eye moving* (*i.e.*, analytic vision) or the shifting of vision from one part of an object to another as otherwise the eye develops a mentally sightless stare.

Stout also points out that association is necessary to enable analytic vision to produce synthetic vision or the necessary fusion of scattered perceptions into one perception, for he writes, "Even more important is the fact that the binocular fusion (he is referring to stereoscopic effect, but it would seem equally to apply to seeing several letters as a single word) of disparate impressions so as to yield a single sensation is itself to a large extent determined by associative suggestion. It is not true that fusion and non-fusion depend only upon anatomical conditions—on the degree of disparateness of the retinal impressions. Retinal impressions equally disparate may or may not fuse. Whatever, in accordance with past experience, tends to suggest that we are looking at a single thing favours fusion."

Now from all this it seems possible to devise a working method for overcoming word blindness, namely, to acquire synthetic vision by means of analytic vision and association.

All words must be analysed or broken down into their smallest parts and then synthesised again by associations. As with the case of the man previously blind who can only see mentally one object at a time, so synthetic vision must in the first instance not

be called upon to extend beyond one letter at a time. Should difficulty be found in learning to recognise single letters, as Dr. Orton points out is sometimes the case, the interaction of tactual and visual perception might be utilised by a child being supplied with raised letters which can be felt by touch. Association might also be made use of by having (as advocated in Pitman's book on memory training) pictures of objects in the form of letters, *e.g.*, a snake forming the letter S.

Then when all letters are thoroughly known two-letter words only should be learnt. These should be learnt first of all by analytic vision, that is to say by splitting them up into, or regarding them as, two separate letters until sufficient synthetic vision is acquired to fuse them by association or see them as a single unit. Passages in books should then be read, picking out all known two-letter groups such as those underlined in "*Now this is the best method.*" This is a form of analytic vision which by breaking down words will gradually extend synthetic vision so that it will gradually absorb even the longer words thus broken down. For "now" is no longer a meaningless collection of letters, it is the word "no" with a letter after it, that is to say in its written form it has acquired a definite personality which differentiates it from other words, and all thought has to move by way of differentiation.

When all two-letter words have been thoroughly mastered in this way the same procedure should be followed with three-letter words and then with four-letter words in order gradually to extend synthetic vision. If, however, this analytic form of gradually progressing is departed from and many-lettered words are sought to be memorised too soon the eyes will develop a kind of mental stare incapable of taking in the words which by differentiation and association have acquired no definite personality, or word blindness will result. When two-, three- and four-letter words have been thoroughly mastered, the important two- and three-letter limbs of words, which are not themselves actually words, should be learnt, and then passages in books read picking these out, *e.g.*, ly, ed, ing. (When doing this it is probable that words written in fairly small type may actually be easier to grasp than in unusually large type because, at least in so far as what is known as local sign is concerned, synthetic vision has less with which to contend.) It will be observed that by this analytic method we are learning to spell correctly even longish words because we are noticing the parts of which they are composed.

If it is frankly admitted that the above method will defeat word blindness, the question still presents itself, why do some people require to use such a method when most people can learn to read

without any method at all? The explanation may be that at least until puberty the word blind child is slightly hypothyroid so that although he sees a word its image does not, so to speak, eat into his senses and leave a lasting impression which association on a subsequent encounter can recall. Be that as it may the important point is that word blindness can almost certainly be overcome in almost every case merely by systematically developing synthetic vision by means of analytic vision.

THE ONE-EYED WORKER*

BY

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THE eye injuries of this war and the ever recurring eye injuries in industry are adding thousands to the present mass of one-eyed people. What is the position of the one-eyed men and women in the labour market? What jobs should they take up? In this paper I shall attempt to answer these questions.

In the course of my investigations in 1938 on the employment of the one-eyed worker in industry I asked the Industrial Welfare Society to send out a questionnaire to its 750 member firms. This questionnaire asked for information about the employment of one-eyed men and women, their efficiency at work and their accident record. Replies were received from 398 firms which employed about 1,000,000 workers. The greater number of small firms stated that they did not require employees to pass eyesight tests and that they employed one-eyed workers. Other firms representing the same branches of industry as the above insisted on eyesight tests; some among these refused to employ one-eyed people; others selected them for special jobs only. From these replies I learned that one-eyed men and women are employed in mines, iron and steel works, in the manufacture of chemical and electrical goods, and also in the fine close work necessary in the manufacture of artificial silk yarn, woollen goods, etc. All firms which employed one-eyed workers were satisfied as to their efficiency at work and their accident record.

One-eyed people can be divided into two groups: (1) those who have lost an eye since childhood and (2) those who have lost the vision of an eye in adult life as a result of disease or injury. The first group are in no way handicapped and have full confidence in the carrying out of their work. One finds the men of this group

* Received for publication, March 1, 1945.

employed in the building trades—working on ladders, on scaffolding, roofs, etc.; in the engineering trades working on every type of machine; in the tool making industry where great precision is required; and doing clerical work in offices. They are just as quick and efficient as their fellow men who work with both eyes. In the labour market these men and women have suffered until now few disadvantages. If their external appearance is normal no comment is made unless a visual examination is carried out. In recent years many large industrial establishments have instituted pre-employment visual examinations. The Factories Act of 1937 provides that juveniles (14-16) should be examined by the examining surgeon and that an eyesight test be carried out. It is obvious therefore that this group of one-eyed people will in future find greater difficulty in the selection of trades and professions.

The second group of one-eyed workers comprises those who have lost an eye during adult life. For the purpose of this investigation in 1938 I examined 100 men and women who had lost an eye within the previous eight years. They were patients at the Royal Eye Hospital, London, where the investigation was carried out. An enquiry was then made into the following points: (I) Trade and occupation when the accident to the eye occurred. (II) The time taken for readjustment to monocular vision. (III) Period of enforced absence from work. (IV) The subsequent employment of the injured worker. The results of the enquiry were as follows: (I) The greatest number of eye injuries occurs in the mining industries and the metal and engineering industries. Most of the men examined had lost their eyes while engaged in such processes as hammering, chipping, boring or milling. (II) After the excision of an eye the patient takes a little time to adjust himself to the new visual conditions. The usual errors in the estimation of distances are made by all during the first few weeks following the loss of an eye. Thus patients will notice that when pouring out tea from the pot they spill it; objects appear nearer to them than they are; they miss the handle of the door when trying to open or close it; ashes from a cigarette are often tipped outside the ashtray, and so on. All these mistakes become obvious to the patient and he gradually notices them becoming fewer and his judgment of distances becoming more accurate. The period of the new visual adjustment takes from a few weeks to some months. Several of the men who were examined had regained confidence in the judgment of distances 14 days after the excision. The ability to estimate depth is also gradually regained. The degree of depth perception acquired depends upon several factors: (1) intelligence and previous experience. Thus drivers, engineers and fitters who have had to judge distances and to carry out fine precision work before their accident quickly acquire the ability of

depth perception and depth estimation; (2) age—young workmen adjust themselves to the new visual conditions much more quickly than older people who take longer to regain their confidence and remain nervous and anxious especially when negotiating traffic in busy roads; (3) sex—women are very slow in getting accustomed to the new visual conditions and their depth perception remains inaccurate for some time after the accident; (4) the loss of the dominant or master eye. The loss of the master (dominant) eye produces greater disability and delays adjustment to monocular vision. I examined a number of men and women, who, after the loss of the master eye experienced difficulties at home, in the street and at work. The following history of two patients will be of interest. Both were engineers before their accidents. One man lost his right eye which was the master eye. He was unable to return to fine precision work. The other man lost his left eye which was not the master eye. He returned to his work of drilling metal doors with a drilling gun where the holes are often as small as one-sixth of an inch. He did this work very efficiently.

In assessing the loss of working capacity in a person who has lost the vision of an eye it is important to ascertain whether the injured eye was the master. Investigations have shown that in 72 per cent. of people the right eye is the master eye. Several tests can be used to ascertain if the one-eyed person is left with the master eye. For example there is the pointing test which involves asking the patient to point quickly to a small near object. Accurate pointing proves the presence of the master eye.

P. C. Livingston has devised an instrument which, working on similar lines, enables one to find out if the one-eyed person is left with the master eye. The patient looks at a short white rod which is fixed at the end of a long bar. A movable black rod is situated midway between the patient and the white rod. The patient is asked to move the black rod laterally until it hides the white rod. The degree of movement is measured on a scale. The amount of movement from the median plane is small when the patient uses his master eye and large in the opposite case.

(III) *The period of enforced absence from work.*—Convalescence after the removal of an eye together with the time necessary for the patient to regain confidence to return to work should rarely exceed two to three months and yet I found during the course of my investigation that the greater number of men after the loss of an eye stay away from work for periods varying from six to nine or even ten months. A number of factors are responsible for this delay in the return to work. (1) Fear and lack of confidence to work under the new visual conditions. This may be a very important factor and cause the workman to stay away from work for several months. The examining ophthalmic surgeon has often diagnosed this condition as malingering. Such a

diagnosis is the result of lack of knowledge of the psychological condition of a patient after the loss of an eye. Patients suffer from a genuine fear of injury to the other eye if and when they return to work. Their limitations in the field of vision and the mistakes they make in the judging of distances, heights and speed of vehicles, etc., causes them to be conscious of the dangers which will confront them when they resume work. These men require careful rehabilitation. On many occasions I have advised such men to carry out simple tasks at home; such as knocking nails into a board, using a screwdriver, etc. These simple exercises combined with the playing of a ball have greatly accelerated the process of visual readaptation, thus enabling the injured men to return to work sooner. It would indeed be helpful if rehabilitation centres were established at eye hospitals and training centres. There the one-eyed men and women could receive training for specified work and psychological treatment could be given where necessary. (2) Compensation and litigation difficulties represent the next factor delaying the patient's return to work. I hope that the new bill on Workmens' Compensation will safeguard the interests of the injured worker and enable him to return to work as soon as he is fit. If necessary the settlement of the claim should be left to a later date, after the resumption of work. This procedure would save the one-eyed worker many months of unnecessary hardship resulting from the loss of wages. (3) The last and very important factor causing delay in the return to work is the unwillingness of firms to employ one-eyed workers. It should be made well known that the experience of many welfare and safety departments attached to several large factories in this country has shown that one-eyed workers after the initial period of accustoming themselves to monocular vision are for practical purposes as fully efficient as two-eyed people. Detailed accident statistics kept by the safety departments indicate that there is no evidence to show that one-eyed persons are more prone to accidents than the normal-sighted.

(IV) *The subsequent employment of the one-eyed worker.* —The greatest number of eye injuries occurs in the engineering and metal industries and an enquiry has been made into the employment of the one-eyed workers of these trades. Many firms refuse to put the men back on to their former jobs indicating that it is dangerous for them to be in the engine or tool room. Such firms usually put the one-eyed workers on to jobs in the store room or yard. On the other hand a large number of engineering firms reinstate the one-eyed worker in his former work of grinding, turning or drilling. Some workers may find difficulty in the first few months. They may make mistakes in their work and often complain of headaches and of pain in the eye. In the course of

time their work becomes satisfactory. The difficulties of the one-eyed worker begin when he loses his original employment. Other employers refuse to employ him in the machine rooms. The inevitable result is that many of them drift into other occupations.

I am often asked by parents of one-eyed children and by labour managers of large industrial establishments what occupations I consider suitable for one-eyed people. Of course this depends on the vision of the one good eye. If the vision of this eye is 6/6 or 6/9 the one-eyed person can follow comfortably all occupations involving close work such as the professions of medicine and dentistry, draughtsmen in surveyor's or architects' offices, clerical work, watch making, jewel work and even the fine close work required in the manufacture of artificial silk yarn or hose, and the inspection and manufacture of electric light bulbs and radio valves. In the metal and engineering trades the one-eyed men with 6/6 or 6/9 vision are fit for most jobs, but of course I would advise against employment in operations which present a greater danger of injury to the good eye. If the vision of the good eye is 6/12 I would advise against constant close work and would suggest employment in the food and distributive trades, building trades or many others. In this country one-eyed people with 6/12 vision can pass the driving test for motor vehicles. There are no official statistics as to car accident records of one-eyed people. In my experience there are no reasons against the employment of one-eyed drivers. If the vision of the one eye is less than 6/12 I would suggest that gardening, farming or domestic service are the most suitable occupations.

The eye injuries of this war will add a large number of men to the mass of one-eyed workers. Many of these men will be anxious to return to their pre-war employment. Will it be safe for them to do so in all cases? I would certainly say no. The danger of injury to the remaining eye should always be considered when men wish to return to work in the engineering and metal trades. The men should be advised against returning to work which involves chipping, hammering or the drilling of metal. They should not be employed in underground work in the mining industry. Rehabilitation centres should bear this in mind when preparing the one-eyed worker for future work. The examining factory surgeons and industrial medical officers should always remember that although one-eyed men and women are fit for most jobs the safety of the good eye should be the first consideration.

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OPERATION FOR CORRECTION OF PARALYTIC EXTERNAL (LATERAL) RECTUS PALSY*

BY

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HOVE

THE following account of an operation for the correction of palsy of the external rectus in two children may be of interest.

Case 1.—This child, a girl of nearly 4 years of age, had palsy of the right external rectus. The history suggested a birth injury. The right eye was amblyopic, and the following glasses were prescribed, R.E. plus 2·0D. Sph., L.E. plus 1·50D. Sph. Her vision with glasses tested with the " E " was R.E. less than 6/60 L.E. 6/12. The right eye was unable to fix. The objective angle of convergence was approximately 45 degrees. Eight months later the objective angle of convergence with the glasses was the same, namely plus 45 degrees.

The operation was performed the next day. Eight days later the angle on the synoptophore was minus 5 degrees, thus showing a slight tendency to diverge, but on the ninth day the angle was plus 3, measured when she was looking straight ahead. The angle, however, was very variable. On the sixteenth day the angle was plus 5 with glasses. There was also a beginning of the power to abduct the right eye about this time, and by the twenty-first day this had become much stronger. On the twenty-fifth day the objective angle on the synoptophore was plus 5 degrees with glasses, and plus 10 without, and she appeared to have the power to abduct the right eye fully. In fact she was so proud of this accomplishment, that she would turn her eyes rapidly to the right and left for the entertainment of anyone who would watch her.

The reason for doing this operation was primarily " cosmetic," and this desirable result has been obtained, but it will be interesting to see if it will now be possible to improve the amblyopia, and even perhaps, when she is older, to get binocular vision.

Case 2.—This girl is 5 years old, and has had palsy of the left external rectus since birth, but, as the left eye is not amblyopic, she turned the head over the left shoulder. The objective angle of convergence was 20 degrees, and the angle increased to 35 degrees when looking to the left. Her synoptophore readings three weeks after the operation were " Angle on synoptophore minus 10 degrees (divergent) fixing with the right eye, and minus 15 fixing with the left. Projection is true. The fusion angle is

* Received for publication, February 9, 1495.

minus 10 L/R 3. No amplitude at present. She is sometimes binocular, but has no power of convergence yet." The next day the readings were the same as the above, but she began to show some signs of convergence on the synoptophore. The next day she was able to adduct 15 degrees. A week later the subjective angle on the synoptophore was, fixing with right eye, minus 5 looking straight ahead, 0 looking to the left; fixing with left eye minus 10 looking straight ahead, 0.looking to the left. The fusion angle was now minus 5 degrees. Thus the over-correction was steadily being reduced, and the power to adduct beginning to develop.

The head tilt was greatly improved immediately after the operation, but as the left sterno-mastoid seemed stiff, and there was still some slight postural torticollis, she was sent to the Physio-therapeutic Department of the Royal Sussex County Hospital for treatment.

Unfortunately I have not been able to follow this case further as she has returned to her home in London, but I have asked one of the London Ophthalmic Hospitals to take charge of her. This operation was done primarily to correct the torticollis, and it would appear that she should with orthoptic training and physio-therapy make a good recovery.

Operation

In both cases the same operation was performed, and so only one need be described. This operation was in every respect but one similar to that described by W. B. Lancaster in Berens' "The Eye and its Diseases," and also by Magnus in the *Brit. Jl. Ophthal.* in May, 1944. The internal rectus was first recessed, being stitched to the sclera slightly anterior to the equator. The performance of this recession is where this operation differs from that described by Lancaster. The external rectus was next exposed and shortened by cutting it through about 2 mm. from its insertion. The outer third of the superior and also of the inferior rectus were next prepared in the manner described by Lancaster, and their free ends stitched to the stump of the insertion of the external rectus. The shortened external rectus was then stitched to the sclera anteriorly to its original insertion, thus performing a resection and advancement of the external rectus. The conjunctival incision was closed. There is no need to give further details as the operation has been clearly described by Lancaster, who ends his accounts by saying "the results are excellent."

My reasons for reporting these two cases are, first they support his conclusion, and secondly I consider that the synoptophore readings taken before and after the operations are of interest, and

may be a guide in other cases. They show what a large angle can thus be overcome, and the almost daily improvement obtained by orthoptic training after the operation. My only regret is that I did not have a photograph of the children taken before the operation, so that I could have another taken afterwards. In his paper of May, 1944, J. A. Magnus states that his case had little or no power of abduction after the operation, but in my first case the child has developed this power, and it seems possible that the second may also do so. As regards the advisability of recessing the internal rectus in these cases, this point must be left to the individual judgment of the particular surgeon, who should base his conclusions on the synoptophore readings taken before the operation. For myself, I am far from convinced that an advancement should be ever performed without a recession of the opposing muscle, though the recession may have to be only part of the way between the insertion and the equator.

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PENICILLIN IN OPHTHALMOLOGY*

With special reference to its application in treatment outside hospital

BY

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THE scope of penicillin in the treatment of diseases of the eye has been widely discussed in recent papers by Milner (1944), Robson (1944), Florey and Florey (1943) in this country, and von Salmann (1943, 1944) and others in America. It is our purpose here to record our experiences in its use which has been largely directed towards ascertaining its value in self administration by patients

* Received for publication, July 3, 1945.

in their own homes. We have by this means been able to eliminate the necessity for admission to hospital in many cases and to shorten the patient's stay in others. In these days of severe shortage of beds, this is no mean advantage. We also record here methods of application of penicillin and some points of laboratory technique which we have found convenient.

During the last six months we have used penicillin in the treatment of over 150 patients.

Clinical application

We have used solutions, cream and powder, but chiefly cream, which we prefer for the simplicity of its application.

1. Solutions. Normal saline was used as the vehicle throughout, and though not isotonic with tears, has proved entirely satisfactory. The use of solutions, however, necessitates the confinement of the patient in hospital.

Solutions are put up in E.M.S. perforated screw-capped bottles and are stored frozen as far as possible. We have not been able to show any deleterious effect on the solution by contact with the rubber washers in the few experiments made. Solutions of more than 100 units per c.c. retained their potency for many weeks in the refrigerator and for at least a fortnight at room temperature, providing they were not contaminated. To avoid contamination, we found it satisfactory to instruct the nursing staff to withdraw the penicillin into a syringe with a fine hypodermic needle, both needle and syringe being sterilised by boiling.

Solutions were applied as follows :—

(*a*) Instillation into the conjunctival sac of penicillin 250-500 U/c.c. This was used in cases of acute conjunctivitis with secondary corneal ulcers. It can only be applied to in-patients for the reason mentioned above, *i.e.*, the necessity for ensuring asepsis. Instillations were made two hourly during day and night for the first 72 hours, and after this period during the daytime only. Signs of improvement were observed after two or three days treatment with complete cure in 5-7 days.

(*b*) Instillation into the conjunctival sac of a solution of 1,000 U/c.c. was given in four cases of serpent ulcer of the cornea. The solution was instilled two hourly during day and night for the first five or six days and continued by daytime only after this. The treatment was combined with irrigation of the lacrymal passages with a less concentrated solution (250 U/c.c.) twice daily. Cure was obtained in 10-14 days. In all but one case, a fine superficial scar remained; the exception healed without any visible scarring. Hypopyon was present in all cases.

Two cases of gonococcal ophthalmia—one a child of four and

one an infant of two weeks—were treated in a similar manner. All discharge of pus ceased after three days treatment in both cases. The patients were allowed home on cream and came up for examination once every two days. Complete cure ensued in one week and the bacteriological findings were negative fourteen days after all treatment was stopped. No corneal involvement occurred in either case.

(*c*) A concentrated solution of penicillin was used in a case of penetrating wound of the sclerotic before suturing the wound. The wound healed by first intention in five days, but low-grade iritis supervened in about a month and it was felt advisable to remove the eye owing to the risk of sympathetic ophthalmia. It should be pointed out that at no time was there any evidence of infection.

We observed two cases of endophthalmitis, one part of a pneumococcal pyaemia, the other after a penetrating injury previously treated outside the hospital and sent in after ophthalmitis had developed. In the first case—a patient aged 78 years—10,000 U/c.c. was applied to the anterior chamber through a keratome incision. It was repeated on the next day, but this being unsuccessful, we changed the treatment to systemic penicillin. Hypostatic pneumonia developed and the patient died two days later. The eyeball was full of pus and there were signs of involvement of the orbital tissues and we could not observe the slightest improvement. The second case was one of a penetrating wound of the cornea with traumatic cataract and secondary iridochoroiditis —culture of the aqueous yielded a profuse growth of Neisseria meningitidis. The patient had three applications of 20,000 U/c.c. penicillin to the anterior chamber. This treatment was combined with one intravenous injection of T.A.B. vaccine. The hypopyon was syringed out of the anterior chamber with the penicillin solution on each occasion and enough of the solution was allowed to remain to keep the anterior chamber reformed. Complete cure was obtained in 10 days.

(*d*) Injection into the tissues was carried out in all cases of acute dacryocystitis where there was no definite abscess formation, and also in cases of minor suppurative affections of the lids, such as styes, suppurating Meibomian cysts, etc. Solutions of 1,000 U/c.c. were used and cures were obtained in 24-48 hours. This method can only be applied either under light anaesthesia, or with previous injection of 2-4 per cent. novocaine, started from an inflamed surface of the skin and injected very slowly. The latter method is more satisfactory because penicillin causes severe pain for ½-1 hour if injected into the tissues—the more so in the case of a cellulitis. Novocaine anaesthesia, however, lasts long enough

to render the above described procedure entirely painless. As adrenalin has been reported as having an inactivating effect on penicillin, it should be omitted from the local anaesthetic in these cases.

(*e*) Irrigation with 250 U/c.c. solution was applied in the after-treatment of an abscessed dacryocystitis after opening. It was done through the wound and through the lacrymal canaliculus. It was found that the cavity ceased to suppurate and assumed a healthy appearance in a much shorter time than is usual in these cases.

2. Cream. The modified Halden base of 30 per cent. lanette wax in water has been used. We found that one batch of this base became strongly acid (pH 3) after autoclaving, resulting in the destruction of any penicillin mixed with it and causing pain when applied to the conjunctiva. It is, therefore, necessary to adjust the pH of the base to 7·2 after sterilizing and we then find that it can be autoclaved for a second time without further change taking place. This difficulty of which we were previously unaware was first suggested to us when patients began to complain that the application of the cream was painful. Investigation of the cream made from this batch showed not only that it was acid, but that penicillin was completely absent. It is, therefore, essential that the potency of each batch of cream should be assayed bacteriologically. Penicillin solution is added to the sterile melted cream and after rapid mixing is poured immediately into tin applicator tubes of 4 gm. capacity, which have previously been plugged with cotton wool and sterilised by autoclaving. The open ends are closed with flamed forceps and the tubes are at once cooled in the refrigerator where they are stored until required. While it is doubtless desirable to add the penicillin to the cream at the lowest practicable temperature, we have been unable to show any loss of potency after penicillin cream has been immersed in a boiling water bath for 10 minutes, and as the pouring of the cream is naturally greatly facilitated by the higher temperature, we do so at one of 80-100 deg. C.

The application of cream seems to be so far the only method for out-patient treatment. We use a standard strength of 250 U/gm. The screw-capped applicator tube prevents contamination from outside and the small quantity given to the patient is used up before it becomes inactive by being kept at room temperature in the patient's house. A great number of patients received such treatment. Typical cases were as follows:—

Acute conjunctivitis with or without corneal ulcers. Chronic conjunctivitis. Marked ectropion with severe chronic infection of the conjunctiva. Blepharitis. Recurrent styes. Eversion of the lacrymal punctum.

In all cases, treatment was preceded by culture from a swab and sensitivity test, usually performed directly by placing two or three dabs from an applicator around the periphery of the plate.

In acute conjunctivitis, complete cure was obtained in 8-12 days with four hourly application of penicillin cream to the conjunctival sac. Considerable improvement was noticed as soon as the third day of treatment. In cases of marginal corneal ulcers, treatment was combined with one daily instillation of 0·25 per cent. scopolamine solution for 4-8 days.

We treated three cases of marked ectropion with severe chronic infection of the conjunctiva and had two cases of eversion of the lacrymal punctum under observation—all over 70 years of age. Cultures showed staphylococcus pyogenes in all cases and penicillin cream was applied. The two eversions healed completely in two weeks with the eyelid back to its original position. No recurrence was seen within two months. Of the three cases of severe ectropion, two healed in 4 weeks and the eyelids returned to their original positions. In one case, Snellen sutures were inserted and penicillin applied. The sutures were removed after 10 days and penicillin continued for 4 weeks with success. No recurrence was seen within 6 months.

Recurrent styes respond excellently to penicillin treatment. We treated the cases until the marginal redness cleared up completely and instructed the patients afterwards to repeat the applications for 3-4 days, at intervals of 2 weeks.

Cases of chronic blepharitis appear to be the most resistant to treatment. A large number were observed. In these cases, interrupted treatment proved to be the best. Application, as in the case of styes, was advised three times daily at first, with an interval of 10 days, and twice daily when resumed.

We have to report here two cases of serpent ulcer with hypopyon who refused admission to Hospital, thus leaving us with no alternative but out-patient treatment—with penicillin cream. Atropine was prescribed and the patients were instructed to apply the cream at three hourly intervals. Before the patients left hospital, we irrigated the lacrymal passages with penicillin solution and repeated this when the patients came for re-examination. Both cases were cured in three weeks. Nevertheless, we obviously do not think that cases of hypopyon ulcer should be treated as out-patients—at least for the first week—as the varying intelligence and skill of the patients would allow of too much hazard.

We have investigated the stability of penicillin creams at room temperature and at 2-4 deg. C. It appears that creams containing penicillin in the region of 1,000 U/gm. retain their potency for

at least 3 weeks at room temperature and 14 weeks in the refrigerator. Similar results were obtained with cream containing 100 U/gm. but one of 10 U/gm. deteriorated rapidly after 3 weeks. We also tested creams which had been issued to patients and had been returned to us at the end of the treatment.

The results were as follows :—

Stability of penicillin creams—creams made up to contain

Weeks	1000 U/Gm.		100 U/Gm.		10 U/Gm. *	
	Room temp.	Frig.	Room temp.	Frig.	Room temp.	Frig.
0	16	15	12	12	2	5
1	17	17	12	12	4	5
3	16	17	11	13	3	5
7	12	16	10	12	0	4
14	10	15	4	10	0	0

* Discrepancy between the initial zones was due to uneven distribution of penicillin in the original sample.

The creams used by patients and returned showed—

	Content U/Gm.	Days in Frig. before issue	Days used at Room temp.	Zone of Inhibition
1	1,000	1	43	9
2	400	3	13	12
3	400	16	—	15
4	250	1	21	10

NOTE 1.—The figures indicate zone of inhibition of the Oxford H. Staphylococcus in millimetres.

NOTE 2.—Tube No. 3 serves as a control to Tube No. 2.

In view of these results we put up tubes of not more than 2·5 – 3 Gm. penicillin cream which is sufficient for 7 – 10 days of treatment. A number of tubes were put up with 1 per cent. phenoxetol as a preservative.

3. Powder. Powders are made up in sulphathiazole powder, containing 5 per cent. magnesium oxide, in 50 gm. lots in sterilized 8 oz. flat medicine bottles, as described in the M.R.C.

memorandum. To each bottle 100,000 units of calcium penicillin powder is added giving a final strength of 2,000 U/gm. Potency appears to remain unimpaired for many months when stored in a refrigerator. The powder is issued in small quantities as required in screw-capped bijou bottles.

Powder was used in some cases of corneal ulcers as initial treatment, and in dusting infected areas, such as acute dacryocystitis after incision, and during after-treatment, and also for dusting the cavity and around after dacryocystectomy, in cases of chronic dacryocystitis. Applied to the conjunctival sac, it is a very effective way of treating torpid ulcers. Although the patients complain of prolonged " gritty " feeling, we can strongly recommend this mode of application. Another advantage is its long stability that makes it possible to carry and keep it anywhere without the danger of becoming ineffective.

In one or two cases of chronic conjunctivitis, with suspicion of nasal origin, justified by a growth of staphylococcus pyogenes from a nasal swab, we applied penicillin powder snuff. In both cases the condition improved, but we cannot report any permanent result as yet.

The purpose of this paper is to try to picture the *routine* application of penicillin at the Eye Department of a country hospital. We hope it will be of some practical value when penicillin will be available in commerce and ophthalmic surgeons outside hospital departments will make regular use of it.

We are indebted to Professor T. B. Davie, University of Liverpool, for the supplies of penicillin and for his guidance, to Sister E. Davies for carrying out most of the treatment on in-patients, and to Mr. R. Munro, F.I.L.M.T., for his valuable technical assistance.

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RUPTURE OF CHOROID ASSOCIATED WITH CYST OF VITREOUS*

BY

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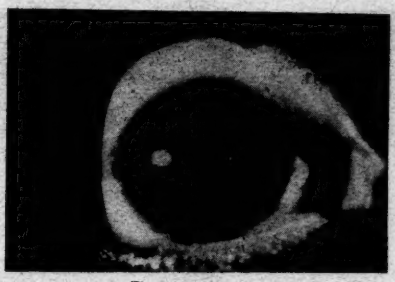
IN the December, 1943, issue of the *Brit. Jl. of Ophthal.*, I reported two cases of " rupture of the choroid " and having at once become more interested in this phase of traumatophthalmology I have been particularly " on the alert " for other unusual cases of choroidal rupture which paradoxically are by no means rare. Because of the uniqueness of this case I am herewith submitting a brief resumé of the history along with a description of the eye findings, a fundus drawing, and pictures of the anterior eye.

In the fall of 1942 while playing soft ball, the patient, a coloured male, aged 21 years, while " batting," struck himself in the right eye with a " foul tip." The batted ball landed directly upon the summit of the right cornea, for the lid closure reaction did not occur promptly. The patient was seen immediately by his physician who told him that he had an abrasion of the cornea along with a haemorrhage of the external eye and eyelids. Cold compresses were ordered placed upon the closed eye. The lids could not be opened satisfactorily for about two weeks. When finally the patient was able to open his eyes he noted that there was definite visual impairment in his right eye. About two months after this injury I made an examination with the following observations:

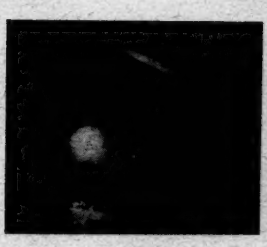
Vision in the right eye was 20/200 and could not be improved with refraction. Vision in the left eye was 20/20. There was no involvement of lids, lacrimal apparatus or motor function although the convergence near point was somewhat remote. The pupil of the right eye was larger than that of the left. The temporal half of the right pupil responded much more promptly than the nasal half to both light and accommodation although a definite reaction was obtained from the nasal half of this pupil.

Slit-lamp examination disclosed a small superficial horizontal scar running across the pupillary area of the cornea. The iris showed a definite break in its sphincteric portion at three o'clock. This was not a " thru and thru " break in the iris but more of a triangular patch of iris atrophy with the base of the triangle directed toward the centre of the lens. The pupil at this point was irregular and the iris had a small notch at its edge. Two other iris notches could be noted above and below this prominent triangular defect. The entire nasal half of the cornea had a

* Received for publication, August, 1944.



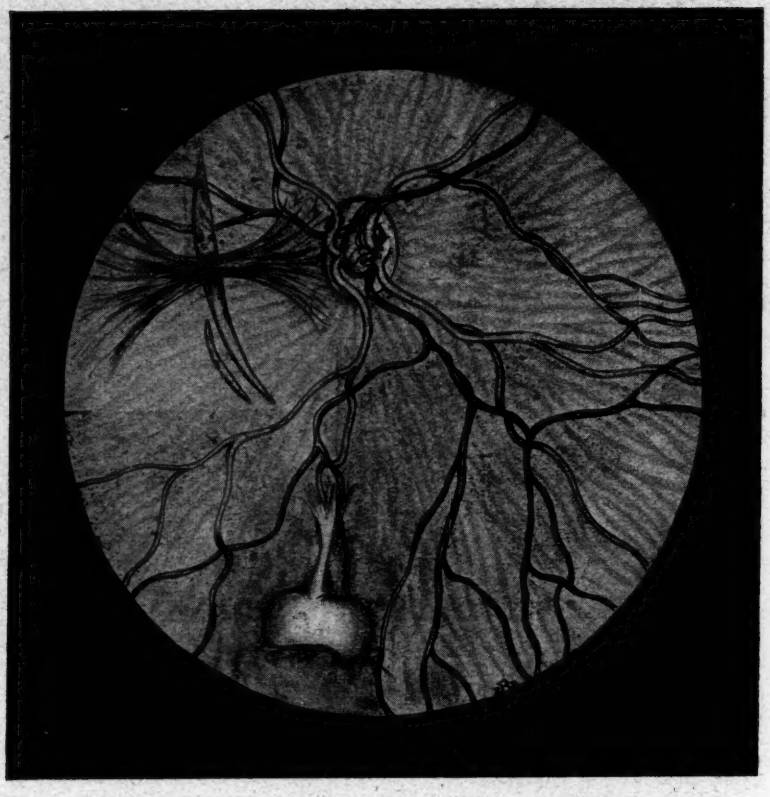
Tears in Iris, pupil dilated.



Tears in Iris, pupil undilated.

deficiency of the small " accordion " like nodules of the inner iris border.

The study of this patient's right fundus was most interesting. A very pronounced choroidal tear was present in the macular region running in a vertical direction and being about three disc diameters in size. Over the centre of this rupture was a peculiar biconvex band whose terminals frayed out in a semi-circular astral radiation. There were no abnormalities of the blood vessels nor irregularities of pigmentation. About six disc diameters below the disc was a very peculiar cystic structure $2\frac{1}{2}$ times the size of the disc and shaped very much like an apple. This sphere seemed to be loosely suspended from a pedicle which would do very well for the " stem of the apple." As the patient looked upward this mass would float away and disappear, but when the patient looked downward the mass would gently settle back into its original position twisting slightly upon its axis and disclosing a variation in colour phenomenon, changing from yellow to pink. Each time the cyst would settle into a pocket formed by a proliferated peripheral connective tissue mass. Its anterior inferior surface could not then be well seen since this proliferative retinal mass covered it over.



The cord-like band from which this cyst seemed to extend appeared to end mysteriously in the vitreous in a number of small digital radiations.

The systemic investigation of the patient was negative as regards any parasitic disturbance; there was no eosinophilia.

The patient was seen every few days for the next four weeks. The only observable change from day to day was an apparent variation in the colour of the cyst and a suggestion of a shrinkage process in the region where the stem joined the " apple " so that several small folds were produced in this area. About one month after the original examination, the patient's fundus was re-examined and it was found that the cyst had ruptured. In a darkened vitreous some stem-like processes could be seen which resembled the stick to which a balloon had been tied and subsequently ruptured leaving many jagged fragments of rubber. The

inferior portion of the vitreous was very cloudy. A poor red reflex was secured from the inferior half of the eye. When studied under the slit-lamp the vitreous was seen to be filled with many brick red deposits unquestionably evidence of degenerated haemorrhage. When last examined the vitreous showed signs of clearing.

About ten years ago I saw a coloured female who had an exudative chorioretinitis along with some peripheral retinal " holes " and what appeared to be a cyst, shaped like a goldfish floating in the vitreous. This structure ruptured and produced a vitreous slit-lamp picture not unlike that of the case herein reported. A hole in the macula subsequently developed in this second case.

In summary I would state that this case presentation shows the relationship of direct " head on " trauma producing a tear in the sphincter of the iris along with a rupture of the choroid. The unusual occurrence of a cyst in the vitreous of traumatic aetiology indicates the tendency toward excessive proliferation and encapsulation of tissue seen in this particular race. In most cases where there is a tear in the sphincteric portion of the iris due to " head on " injury there is more likely to occur a choroidal tear, than in cases where an iridodialysis takes place. Of course, the trauma producing the iridodialysis is not " head on " but usually lateral for the " give " occurs at the root of the iris and the zonular fibres rather than at the inner iris circle and the choroid. Wolff, who reported traumatic cysts of the vitreous in the Transactions of the Ophthalmological Society of the United Kingdom in 1942, believes that retinal cysts frequently develop following trauma and preceding formation of retinitis proliferans.

ANNOTATION

Testimonials

Testimonials may be of many kinds including a gift presented to some one by a body of persons as an expression of appreciation; an affidavit, an official warrant, even a passport as given to vagrants, labourers, discharged soldiers and sailors; and a letter of recommendation of a person or thing. This last item as a definition dates from 1571 according to the Shorter Oxford Dictionary. It is the last instance that specially concerns us, for those applying for posts on the staff of a hospital have to furnish testimonials as to their capabilities for the situation.

Looking over testimonials in after life is not unlike looking through a bundle of old school reports. Some are diffuse, some

laconic. In testimonials naturally the best is made of the subject, whereas in school reports the reverse is by no means uncommon. Testimonials are not always easy to write, but the recipient need not make use of any that he does not like.

One of the best examples of a testimonial we remember to have read was given by a man to his servant. It ran somewhat in this style: "—— has been my servant for six months. Anyone thinking of employing him in a similar capacity would do well to remember Mr. Punch's advice concerning matrimony." But no one ever wrote a better personal testimonal than the awful Miss Pinkerton of Chiswick Mall. She, it will be remembered, recommended Miss Tuffin and Miss Hankey for the post of governess in the family of Sir Huddleston Fuddleston. "Either was perfectly qualified to instruct in Greek, Latin, and the rudiments of Hebrew; in mathematics and history; in Spanish, French, Italian and geography; in music, vocal and instrumental; in dancing, without the aid of a master; and in the elements of natural sciences." Miss Tuffin could also instruct "in the Syriac language and the elements of constitutional law." She was only eighteen years of age and of exceedingly pleasing personal appearance. Miss Hankey, on the other hand, was twenty-nine years of age, not personally well-looking, her face much pitted with the small-pox. She had a halt in her gait, red hair and a trifling obliquity of vision. Mr. Squeers's manifesto on the educational advantages offered at Dotheboys' Hall has always struck us as the best example of recommendation for an inanimate "thing."

ABSTRACTS

MEDICAL OPHTHALMOLOGY

(1) **Fink, W. H. (Minneapolis, Minnesota).—The ocular pathology of methyl-alcohol poisoning.** *Amer. Jl. Ophthal.*, Vol. XXVI,. p. 694, 1943.

(1) **Fink** comments on the lack of precise knowledge about the toxic action of methyl alcohol. It is, as yet, not clear whether the toxic effects on the central nervous system, the liver and kidneys are due to methyl alcohol itself or to its break-down products formaldehyde and formic acid, or to a combination of methyl alcohol and these products, or possibly to some other poison at present unknown.

Clinical and experimental work have shown that methyl alcohol enters the system through ingestion, inhalation, and is absorbed by the skin. Personal idiosyncrasy plays an important part and man seems more susceptible to this poison than animals. Oxidation is

slow and only partial. It is possible that acidosis plays an aetiological rôle in methyl-alcohol poisoning. Elimination of the drug is slow and chiefly through the lungs. It is evident that it possesses a selective affinity for the most highly differentiated nerve elements of man.

The subjective symptoms of methyl alcohol poisoning are a sudden diminution of vision which may be of marked degree. This is followed by gradual improvement in a few weeks, and later by gradual loss of vision which may progress to total blindness. The author explains this by suggesting that there is immediate oedema of certain central ganglion cells and nerve fibres, also the papilla and retro-ocular part of the optic nerve in some cases. The oedema subsides but later some of the cells die as a result of impaired nutrition. Vision depends upon the number of cells which survive.

Scotomata may be single or multiple, a central scotoma being the most constant finding. Frequently there is peripheral contraction of the field which varies greatly in degree and position.

Ocular tenderness on pressure and on movement of the globe is evidence of an ocular or retro-bulbar congestion or oedema.

The author discusses the experimental work of 9 investigators. Three of these failed to find any evidence of histological changes in the retina and optic nerve after the administration of methyl alcohol to experimental animals. The changes described by some of the workers many years ago have been attributed to post-mortem changes and artefacts due to incorrect fixation and staining preparations.

A summary of the work shows that retinal changes predominate, choroidal vessels are congested, the entire retina is oedematous, especially the nerve fibre and ganglion cell layers. The retinal ganglion cells showed marked degeneration, the inner and outer nuclear layers are less affected. This degeneration is patchy and scattered throughout the retina. Degenerative changes are also present in the optic nerves, these are found immediately behind the eyeball and also vary in degree in their patchy distribution.

The author's own experimental work on animals showed the following changes in acute poisoning. Early chromatolysis, vacuolization of the cytoplasm of the large ganglion cells and practically complete disappearance of Nissl substance was evident. In severe cases some disintegration of the layer of rods and cones and oedema of the papilla were present. In the cases of chronic poisoning the above changes were more marked, the disintegration of the rods and cones was more severe and the ganglion cells were reduced to shadow forms. From the histological changes it seemed that the animals reacted similarly to pure methyl alcohol, commercial methyl alcohol and to formic acid.

The author describes the general symptoms and the post-mortem changes in the tissues of the body affected by methyl alcohol.

H. B. STALLARD.

CORRESPONDENCE

OPHTHALMOLOGY AND (1) PENICILLIN, (2) VINEYARDS

To the Editors of THE BRITISH JOURNAL OF OPHTHALMOLOGY.

DEAR SIRS,—(1) In your issue of June, 1945, Juler and Young describe the favourable results which they obtained by local applications of penicillin in the treatment of septic corneal ulcers. They advocate Saemisch sections for serious cases but caution against the risk of anterior synechiae. In septic ulcer with mild iritis and secondary glaucoma it cannot be disputed that this risk is real but in mine cases the pathology is quite different and the risk is less. Here there are multiple penetrations of the globe with retained foreign bodies, severe iritis and traumatic cataract; it is probable that because the iris is so well and truly stuck down that anterior synechia after Saemisch section in these cases were not seen.

(2) These authors also comment on the potency of penicillin in lanoline and vaseline combinations. There is no question that penicillin retains potency in a refrigerator but my tests had to determine what vehicle was most suitable for field conditions and it was found that at room temperature, lanoline was the least suitable. The authors agree with this but perhaps the real argument lies in the difference between the room temperature at Paddington in ? February and at Naples in May. Cameron (*Brit. Med. Jl.*, Feb. 17), has pointed out that penicillin is inactivated by liq. adrenal-hydrochloride 1 : 1000 ***in vitro***; this is due to the Ph of the hydrochloride solution (Ph 2. 8 to 1·2). Penicillin is not inhibited by adrenalin ***per se*** and can therefore be employed for convenience in mydricain injections.

(3) Although vineyards have become an anathema to doctors serving in Italy your apt annotation will be appreciated by Service ophthalmologists abroad. It also offers a favourable opportunity to remove any misunderstandings which may have been created by some of the recent letters in the Medical Press.

There are many differences between the service of an ophthalmologist in the E.M.S. and one in H.M. Forces but there is really only one which counts and that is the main hardship of any doctor's service in wartime, namely domestic separation for long periods.

(4) It is assumed that all ophthalmologists are anxious to serve their country to the utmost of their ability and that those who are not in H.M. Forces are in the E.M.S. It is well known that some E.M.S. surgeons are out of uniform through no fault of their own. Also, a high degree of physical fitness for a specialist in H.M. Forces is neither necessary nor demanded. The examples of older and

senior ophthalmologists who served in the last war and are serving in the E.M.S. now are too well known to need mention here.

(5) Whether the service of a younger man is to be an unlimited offer to serve in H.M. Forces anywhere or to be a limited offer of local service in the E.M.S. is entirely a matter for the individual conscience and is no part of the Services case. Nor does the extent of service in the E.M.S. concern the military oculist overseas and any idea that there is general mistrust in the Services on this account is mischievous and plain nonsense to those of us who are in touch with our E.M.S. friends, or with patients whom we have sent home. No serviceman overseas would presume to judge a situation of which he has little more than fragmentary knowledge.

(6) However, now that the emergency is less it is accepted by all responsible sections of the medical profession that speedy relief is justly due to those who have served abroad for some time in order that the sacrifice of domestic upheaval may be shared.

(7) The prior need of the Army in war is, and always has been, for ophthalmologists of ripe surgical experience, and this need will become more acute as demobilisation of senior and older men of long service proceeds. At present, owing to lack of replacements, Army ophthalmologists who have already completed over two years service abroad are having to be despatched for still more foreign service. Is it not logical that questioning eyes are now looking towards home?

(8) Special arrangements for exchange bristle with difficulties of administration which would inevitably cause delay: they are not now really required. Ordinary recruitment and demobilisation should be sufficient to continue to give our Forces in the Far East what is their due—a first-class ophthalmic organisation. To return to your vineyard, Sirs: would it not be as well for all of us now to reflect on Matthew XXI, verses 28-31?

Yours faithfully,

B. W. RYCROFT.
Lt.-Col., R.A.M.C.

ALLIED FORCE HEADQUARTERS,
OFFICE OF THE SURGEON, C.M.F.
July 5, 1945.

INTRA-OCULAR FOREIGN BODY LOCALISATION

To the Editors of THE BRITISH JOURNAL OF OPHTHALMOLOGY.

DEAR SIRS,—I was interested to read Major Skeoch's article on the use of an "equatorial ring" in the localisation of intra-ocular foreign bodies in the March number of the Journal. As the accurate localisation of the I.O.F.B. plays an important part in ophthalmic war surgery any additional method demands careful study.

The "limbal ring" (following Major H. B. Stallard's classical description in the Journal for March 1944), is in routine use in my department, and I am writing to suggest that it retains several important advantages over the "equatorial ring."

1. *The Direct Lateral X-ray View.*—Since, as Major Skeoch states, the "equatorial ring" does not fit the exact equator the relationship it bears to the anterior and posterior pole of the globe is not known. Thus a circle, corresponding to the diameter of the eye, cannot be superimposed accurately on the X-ray plate and the relationship that this bears to the F.B. be assessed. This valuable relationship can, however, be established when using the "limbal ring."

Major Skeoch says nothing in his article regarding the use of double-exposure, *i.e.*, taking two X-ray exposures on the same plate, one with the eye looking up and the other with it looking down. To obtain absolute immobility of the head during these exposures a clamp is used as devised by Lt.-Col. Lawler (Adviser in Radiology, S.A.), to whose assistance in this work I am much indebted. This is a very valuable procedure, for any F.B. that appears twice and that on both exposures bears the same relationship to each "limbal ring" must be moving with the globe and its position, in relationship to the known position of the ring can be measured. This procedure is at its most valuable when there are multiple F.Bs. present in the orbit. When using the "equatorial ring" the movement of the ring being so small and the exact position of the ring in relationship to the globe not being known, the information obtained from the apparent movement of an F.B. is much less valuable.

2. *The Anterior-posterior X-ray View.*—Here, again, since the ring does not fit the equator accurately, the F.B. while appearing to lie inside the ring and therefore inside the globe may actually be extra-ocular.

It is realised that the "equatorial ring" has two great advantages which give it an immediate appeal, that of simplicity in insertion and that of non-irritation in an inflamed eye. The sewing in position of the "limbal ring" is an operation in itself and although I have not known it to effect adversely an inflamed eye it might well do so.

In view, however, of the above, I consider that the advantages of the "limbal ring" in localisation as compared to the "equatorial ring" are such as to make a change to the use of the latter of questionable value.

Yours faithfully,

L. B. SOMERVILLE-LARGE, Lt.-Col., R.A.M.C.
Adviser in Ophthalmology, S.A.

OPHTHALMIC DEPARTMENT,
SECUNDERABAD, INDIA.
July 4, 1945.

FEES AND ENCROACHMENT ON PRIVATE PRACTICE

To the Editors of THE BRITISH JOURNAL OF OPHTHALMOLOGY.

DEAR SIRS,—I write to congratulate those responsible for the Annotation—Fees—in your Journal of July, which gives timely support to the long-established custom of doctors engaged in private practice being free to name their own fees and modify them to meet their patients' circumstances. As there can be little doubt that the pre-eminence of British medicine is largely due to the freedom this custom gives to patient and doctor alike, I wish to draw attention to facts and figures which apparently have not been seen by the writer of the Annotation, who does not appear to have appreciated how the scope for private practice has been greatly curtailed.

Unfortunately, many of us are to blame for the present state of affairs, by the maintenance of an eighteenth-century taboo which has resulted in little consideration being given to the fact that there has been little, if any, decrease in the calls for gratuitous service, in spite of the increase in social services. In 1913, these cost the country £63,000,000; in 1939 £531,000,000 and are now in the region of £1,400,000,000.

Nor was this the only encroachment on private practice, for in July, 1912, National Health Insurance came into operation and, owing to the conservative policy of the Government, medical benefits were restricted in favour of capital reserves which reached £150,000,000 in 1940. They must be much greater now owing to the low incidence of sickness during the war and the fact that 2,000,000 previously unoccupied people have been brought into industry. State funds are liable to be, and indeed have been, appropriated for purposes other than that for which they are collected, and the profession's high ethical code makes it particularly vulnerable to such a policy, for politicians are very sensitive to the claims of a majority, which is never likely to be obtained by the sick. A further blow to private practice was suffered from the extension of National Health Insurance to include those with incomes up to £420 per annum, and it must be remembered that there is no income limit for manual workers.

The most recent encroachment on private practice is the extended powers given to education authorities under the Education Act of 1944, which imposes on them the duty of making arrangments to secure the provision of *free* medical attention for pupils from the ages of 2 to 15 years, in any school or county college maintained by such authorities. The successful opposition of most of them to the B.M.A.'s recommendation of a 20 per cent. increase in the fees of part-time doctors in their employ, as a war-time measure, is significant, for "sparing justice feeds iniquity."

Fortunately, the public has been as slow to appreciate the

changing circumstances as those to whom we have entrusted our material interests and, therefore, the full consequences have not yet been seriously felt, chiefly owing to the war-time increase in earnings from £1,734,000,000 in 1938 to £2,930,000,000, that is, approximately 70 per cent. The following figures show that the lower income groups have benefited most, and therefore, there is no justification for the doctor-patient-fee relationship to be discarded, at a time when the public has been able to save £9,000,000,000, of which £3,500,000,000 were "small savings," in spite of more being spent on beer, tobacco, clothing and entertainment.

Range of Income after Tax Deduction £	1938-39	1942-43	*Increase or Decrease*
150- 250	4,500,000	7,000,000	+2,500,000
250- 500	1,820,000	5,300,000	+3,480,000
Total	6,320,000	12,300,000	+5,980,000
500-1,000	450,000	550,000	+100,000
1,000-2,000	155,000	117,000	−38,000
2,000-4,000	56,000	31,750	−24,250
4,000-6,000	12,000	1,170	−10,830
6,000 or over	7,000	80	−6,920
Total	680,000	700,000	+20,000

In view of these facts, one is left wondering what is the real aim of those who seem intent on undermining the spirit of independence which was such an estimable characteristic of the British people until a multiplicity of grandiose schemes were announced as being "free for all."

Yours faithfully,

H. RICHARD BICKERTON.

LIVERPOOL,
July 20, 1945.

HETEROPHORIA AND NEUROSIS IN FLYING PERSONNEL

To the Editors of THE BRITISH JOURNAL OF OPHTHALMOLOGY.

DEAR SIRS,—We have read with interest the above article which appeared in the *Brit. Jl. Ophthal.* of March, 1945, but feel that the

conclusions at which the authors arrive should not be allowed to pass without comment.

The article states that of 57 cases of aircrew personnel presenting themselves on account of *certain ocular symptoms*, and in whom some degree of ocular muscle imbalance was demonstrable (by means of the Maddox Rod test), no less than 50 were found as a result of investigation by the usual means of "comprehensive interview and examination" to be suffering from definite well-marked psychological illness.

In these cases, three variable factors are dealt with:—

1. Certain ocular symptoms.
2. Ocular muscle imbalance (heterophoria).
3. The general condition of the patient (with special reference to his psychological state).

We feel that the article does little to clarify the inter-relationship between these factors, particularly as the ophthalmic data supplied are incomplete.

As the authors themselves state:—(1) Small degrees of heterophoria are so common as to be considered almost physiological, and (2) heterophoria may be present without causing any symptoms. One must therefore naturally ask whether in the 57 cases mentioned the ocular symptoms presented were really due to the heterophoria present? None of the presenting symptoms listed in Table 2 of the article, with the probable exception of diplopia, need be due to heterophoria. Moreover, such vague symptoms as "Faulty landing," "Eye strain," "Deteriorating vision," etc., mean nothing unless properly analysed. In fact, most of the symptoms given might be due to a pure ocular neurosis, or to ordinary fatigue. When such symptoms occur in a patient who is found incidentally to demonstrate a minor or even major degree of heterophoria (as tested by the Maddox Rod) it by no means follows that the heterophoria is responsible for the symptoms. A thorough and comprehensive history and ophthalmic examination are essential before arriving at a satisfactory conclusion.

Of the four illustrative cases described, case 1, although incomplete, and without information as to the refraction, is, we agree, consistent with the underlying cause of mental fatigue, and is probably a fairly typical case of esophoria due to spasm of convergence. Such a case we would not consider to be in any way suitable for, nor in need of, orthoptic treatment.

The one prism dioptre of hyperphoria present in case 2 cannot, we consider, be regarded as the cause of the symptoms, and such a case is obviously not to be assisted by orthoptic treatment.

The ocular information about case 3 is so inadequate that comment is impossible. Furthermore, in our experience, the job of

air bombers does not require the possession of a high standard of binocular vision. They are therefore unlikely to experience difficulty in carrying out their duties even if suffering from a symptom-producing heterophoria.

This same remark applies also to case 4. The job of air gunner is primarily a monocular one, in so far as the sighting of his gun is concerned, and therefore the refinements of binocular vision are not of any real importance. Quite apart from this, the history of case 4 points to a diagnosis of mental fatigue, and not an eye condition.

If these cases quoted are a fair representation of the 57 cases dealt with, the conclusions drawn from them cannot be regarded as particularly reliable.

In our experience of heterophoria among flying personnel, we find that cases fall into two main groups :—

1. Types which *can* be caused by extra-ocular factors, such as fatigue or worry, often with a well marked neurotic background :—

(*a*) Convergence insufficiency (especially if associated with esophoria).

(*b*) Esophoria of the "spasm of convergence" variety.

It should be pointed out that these two varieties of heterophoria show a *dynamic* factor as opposed to a purely *static* one. It is usually not difficult in these cases to decide whether the case needs:—

(*a*) Rest.

(*b*) Reference to a neuro-psychiatrist for his opinion as to psychiatric treatment, or

(*c*) Ophthalmic treatment, including orthoptic treatment.

Judgement depends entirely on the past history of the case, the type of symptoms present, and the result of a full ophthalmic examination.

It should be emphasised that it is only in a certain percentage of cases of convergence insufficiency and esophoria that a purely extra-ocular cause exists.

2. Types which *cannot* be primarily caused by psychological factors, although the *onset of symptoms* (due to decompensation) may be determined by unusual emotional stress, fatigue, etc. :—

(*a*) Periodic Divergent squint.

(*b*) Periodic Convergent squint.

(*c*) Hyperphoria.

(*d*) Most cases of Esophoria and Exophoria.

These cases will respond to proper ophthalmic treatment, and in most cases may be completely cured.

The differential diagnosis of these two classes of heterophoria and the decision as to treatment present no problem if the symptoms, history, and ophthalmic findings are co-related as a whole. The latter should include a study of the state of binocular vision, and

the degree of "fusional reserve" or "Duction power" and an examination of the stereoscopic vision.

In this respect, we would state that an individual who has a demonstrable heterophoria (as measured by the Maddox Rod test) may be in a state of:—

(*a*) Full compensation (Symptom-free).

(*b*) Partial decompensation (Symptom-producing).

By *full compensation* we mean that the tendency for the visual axes to deviate is kept in check by wholly sub-conscious factors, and in consequence symptoms do not occur. When a case of heterophoria begins to lose its state of full compensation (*i.e.*, when the tendency for the visual axes to deviate can no longer be kept in check by sub-conscious effort), then the following symptoms may occur as the effort to maintain parallelism of the visual axes becomes conscious :—

(*a*) Headaches and ocular fatigue, especially referable to the use of the eyes for concentrated work.

(*b*) blurred vision, usually periodic, which is a forerunner of :—

(*c*) diplopia, occurring especially when shifting the gaze from a distant to a near object, or vice-versa.

A psychological illness cannot, we consider, produce *per se* a state of static deviation of the visual axes, although it may be, and often is, *one* of the factors in producing symptoms of decompensation in a previously well-compensated case.

In cases of demonstable heterophoria, of a greater or less degree which are discovered as a result of a full ophthalmic examination to be well compensated, if ocular symptoms are present they are not normally regarded by us as caused by the heterophoria, unless there is strong confirmatory evidence in the history.

Admittedly it may be difficult in a borderline type of case, *e.g.*, one of slight convergence weakness associated with defective stereopsis, to be absolutely dogmatic as to whether or not the symptoms are due to the heterophoria present. In such cases it is our custom not to give a course of orthoptic treatment unless the result of a psychiatric examination shows the absence of psychological illness. It is only in a small percentage of the cases passing through our hands, however, that this doubt exists.

In conclusion, we agree that the practice of prescribing orthoptic or other ophthalmic treatment for cases of heterophoria indiscriminately, and without reference to the principles we have mentioned, is to be condemned, and is particularly dangerous among flying personnel.

At the same time, the responsibility for decision as to treatment must rest with the Ophthalmologist in the first instance, although as we state above, consultation with a neuro-psychiatrist is indicated in certain classes of case.

Finally, it is noteworthy that the authors state that in their series only "acquired" cases of heterophoria as opposed to "inherent" cases are considered. It would be interesting to know how they arrive at this distinction.

It would also be of interest to know how the 57 cases were selected.

We are, etc.,

T. KEITH LYLE,
Consultant in Ophthalmology, Overseas.

F. JANUS,
Ophthalmic Specialist.

COMMAND MEDICAL BOARD,
ROYAL AIR FORCE,
MIDDLE EAST FORCES.

NOTES

Oxford Ophthalmological Congress

Mr. P. G. DOYNE has been elected Master of the Oxford Ophthalmological Congress for an extra year, and Dr. Bernard Samuels, Deputy Master.

* * * *

Appointment

Mr. F. J. LAVERY, has been appointed lecturer in ophthalmology at the National University of Ireland.

* * * *

Special Notice

WE are asked by the Ministry of Information to state that the fact that goods made of raw materials in short supply owing to war conditions are advertised in this journal should not be taken as an indication that they are necessarily available for export.